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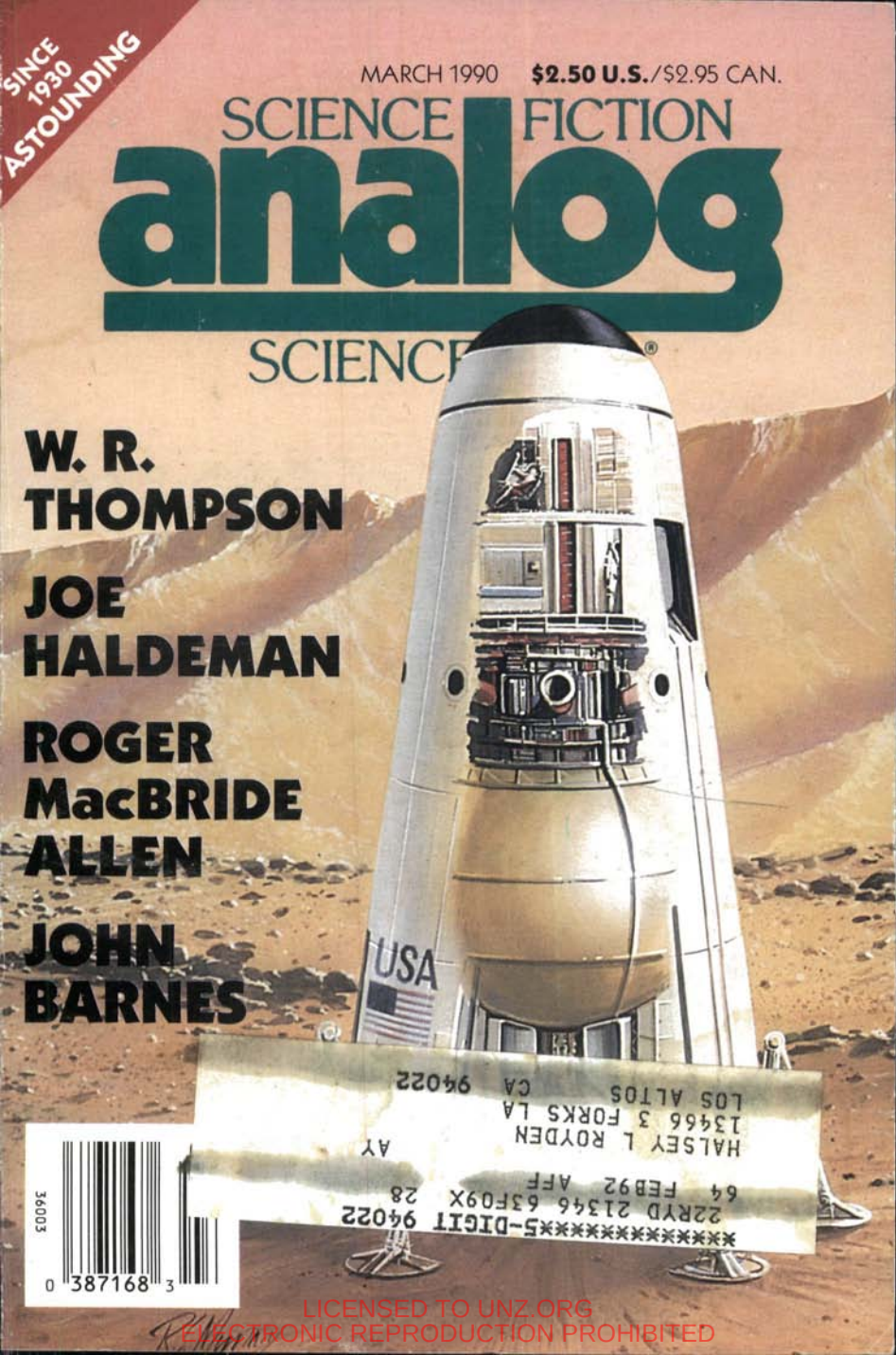

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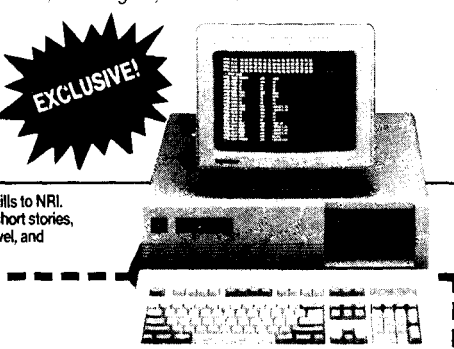

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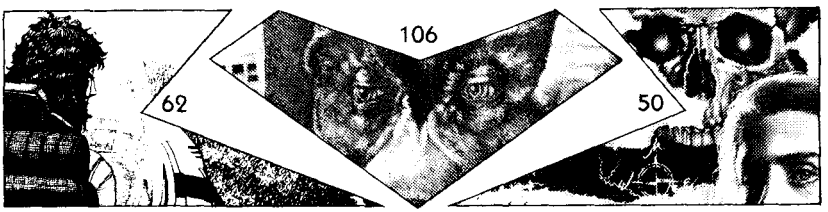

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Editorial

ENGINEERING PROBLEM

Stanley Schmidt

Last May I attended the Space Development Conference in Chicago, which provided an excellent opportunity to hear what people are thinking about our future in space—both space professionals and interested citizens, both in formal presentations and in casual conversation. Robert M. Zubrin's article in this issue is a direct result of that meeting. This editorial is another—but it's not just a plug for the article.

Zubrin's article describes a new concept for travel to the planets, an idea quite likely to strike you as one of the "Why didn't I think of it?" sort. As you'll see from the article, the system described has one essential new feature—the use of fuels (or, more precisely, propellants) picked up on site rather than lugged from Earth from the beginning of the mission. That one difference gives Zubrin's proposal, in any of its versions, huge advantages over any of the schemes currently on official planning boards. Planetary missions operated this way would be enormously more economical, versatile, and flexible than the ones now planned.

Furthermore, the NIMFs in Zubrin's article were not the only system discussed in Chicago that could provide similar advantages for space travelers. Dr. Robert L. Forward, for example, described in considerable detail a propulsion system using the annihilation of very small quantities of antimatter to heat propellants of "ordinary" materials. Zubrin's proposal would give exploring craft much greater mobility, at much lower cost, than chemical rockets of the kinds now in use. Forward's

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would do the same, but even more so. Not only does it allow ridiculously low mass ratios, but the mass ratio turns out to be almost independent of the kind of mission.

So if these ideas offer such advantages, why isn't the entire aerospace industry rushing to adopt them?

In Forward's case, the answer is easy—for the moment. While the quantities of antimatter it uses are very small by meat-market standards, they're still much larger than existing antimatter technology is prepared to produce. If anybody's interested enough, that capability will change; but what we need is not presently in our grasp. Which makes a good excuse for why we're not already going to the stars, Forward's way.

The same is not true for Zubrin's proposal. The equipment and techniques it requires are either already available or clearly within our reach. So what's the problem? Why are some aerospace engineers actively opposing efforts to promote schemes like NIMF, and pushing chemical rockets instead, despite their cumbersome character and huge operating costs?

Let us skip over such crass suggestions as that some folks may feel threatened in their jobs if a new project might out-compete one in which they're comfortably entrenched. The real fear in some circles seems to be that, even if nuclear- or antimatter-heated indigenous fuel systems have it all over chemical rockets in engineering terms, they would never be accepted by the public.

Because the mechanism that drives Zubrin's spacecraft depends on nuclear reactions—what I heard referred to on the radio just yesterday as "the N-word" that only a few reckless souls dare utter. Forward's craft are even worse. They use nuclear reactions, too, but of a kind far more potent than any of the more familiar types. I haven't yet heard anyone refer scathingly to antimatter as "the A-word," but I'm quite sure that's only for lack of familiarity. If and when anybody talks seriously about building "Forward rockets" *here and now*, such attacks will quickly become an everyday occurrence.

I have no quarrel with aerospace engineers who fear that NIMF-like spacecraft would meet a great deal of public hostility and opposition. That seems all too obvious. Where I differ with some of them is on the question of what should be done about it.

The opinions I've heard cover a wide (and not one-dimensional) spectrum. One position is that since there is so much public hostility to anything nuclear, it is a waste of time, and perhaps ultimately damaging to alternative options such as chemical rockets, to push for the development of anything that depends on nuclear components. Another is that rather than arguing in public about safety, NASA should simply state flatly and without apology that the nuclear way is by far the best way to go, and eventually the public will accept it.

Both views seem to me extreme and difficult to support. If the people working in this or any other field know a far better way to do something than the ones currently fashionable, and they know

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that the opposition is based on misconceptions, they are not doing their jobs if they simply go along with the popular but inferior way to avoid hassles. On the other hand, it's unrealistic, and contrary to the basic precepts of a free society, to suppose that the public will change its mind simply because Authority tells it it should. In a country with free speech, people *will* argue about everything, both in public and behind closed doors, and the only way you're going to change their minds about a controversial issue is by winning more of the arguments than you lose.

Engineers who want to send NIMFs to Mars would be well advised not to underestimate the strength of popular opposition to Things Nuclear. It is *not* a trivial problem, or one that they can shrug off and count on somebody else to solve for them.

I suggest a third way to approach it: popular opposition based on misconceptions should be regarded as one of the engineering problems that has to be

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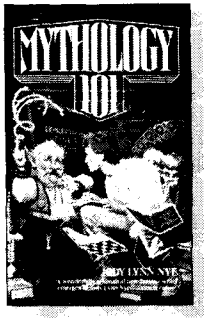

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A WORD FROM Brian Thomsen

When we think of pirates we don't usually assume they're the good guys. Yet who can think of Captain Blood without thinking of everybody's favorite swashbuckling hero Errol Flynn. He may have been an outlaw but he wasn't necessarily a villain.

Such is the case with Bet Yeager, a futuristic pirate who just happened to fight on the side that lost. As an individual, Bet is heroism personified, even if history might call her a buccaneer.

When you see me around ask me for an elf-sided view of real estate developers (or just read MYTHOLOGY 101).

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solved to get the best possible system into use. As such, engineers must expect to do at least part of the work of solving it.

And it ain't easy.

The problem is one of education, of remaking attitudes. And when it comes to nuclear power in any form (or genetic engineering, or abortion, or any number of other things), people's attitudes run so deep, and have so little to do with reason, that rational arguments will not suffice to change them.

If an engineer in any technology wants to get the best possible system into use, and the way that works best runs counter to a fashionable taboo, he's going to have to help change the taboo. It's not the kind of problem engineers like, because human beings do not behave in nearly as simple or logical a way as integrated circuits or rocket engines. Hewlett-Packard does not make a calculator that will tell you, at the touch of a few buttons, how to solve a problem whose roots are firmly entrenched in the emotions of millions of people.

But it's part of the job—and engineers who really want things done a particular way will have to deal with it. It's easy to *tell* people why your way is best, in engineering terms—but if you want them to accept it, somehow or other you must also make them *feel* comfortable with it. ■

EDWARD A. BYERS
1939-1989

Edward A. Byers, well known to *Analog* readers for his "Pan Kirst" series and other stories here, died on September 22, 1989 (his fiftieth birthday), at his home in Springfield, Virginia. He had been fighting cancer for the last couple of years, but continued to write almost until the end. He was able to greet several friends and family who visited on his final birthday before his wife, Lola, found that he had passed away.

Ed grew up in rural Ohio, near Mansfield, and earned a BA from Defiance College and an MA in psychology from Ball State University. At various times he worked as a newspaperman, an engineer, and a technical writer, and a few years ago he and Lola founded and operated their own financial services company, Pegasus. An interest in archaeology led him into volunteer field work on digs. All these aspects of his background left traces in his stories.

He began writing and selling fiction in the late seventies, after encouragement and help from writer Joe Hensley, and quickly became a regular contributor to this magazine and part of an informal group of DC area SF writers to which he paid tribute in the title of his story, "The Vicious Circle." In addition to his short fiction, he wrote two novels which were published by Baen Books, and we can hope that some of the work he left behind will also be published later.

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REDWALL

"...will keep fans of Tolkien and King Arthur tales engaged to the final battle."

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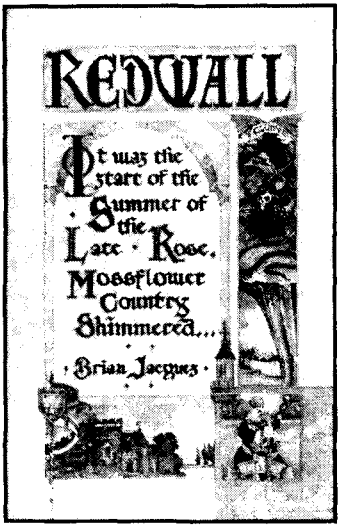

It was the Summer of the Late Rose...

The woodland community of Mossflower thrived around the abbey of Redwall. There had been peace for generations, until the Summer of the Late Rose. Even as the woodland's beauty lingered, evil invaded Redwall. It was Cluny, the scourge. The faith of generations rested on the legend of Martin and his warrior sword. But it was missing, and the peaceful kingdom was shaken by Cluny's barbaric attacks. Only one young mouse, Mathias, still believes and undertakes a quest to save Redwall.

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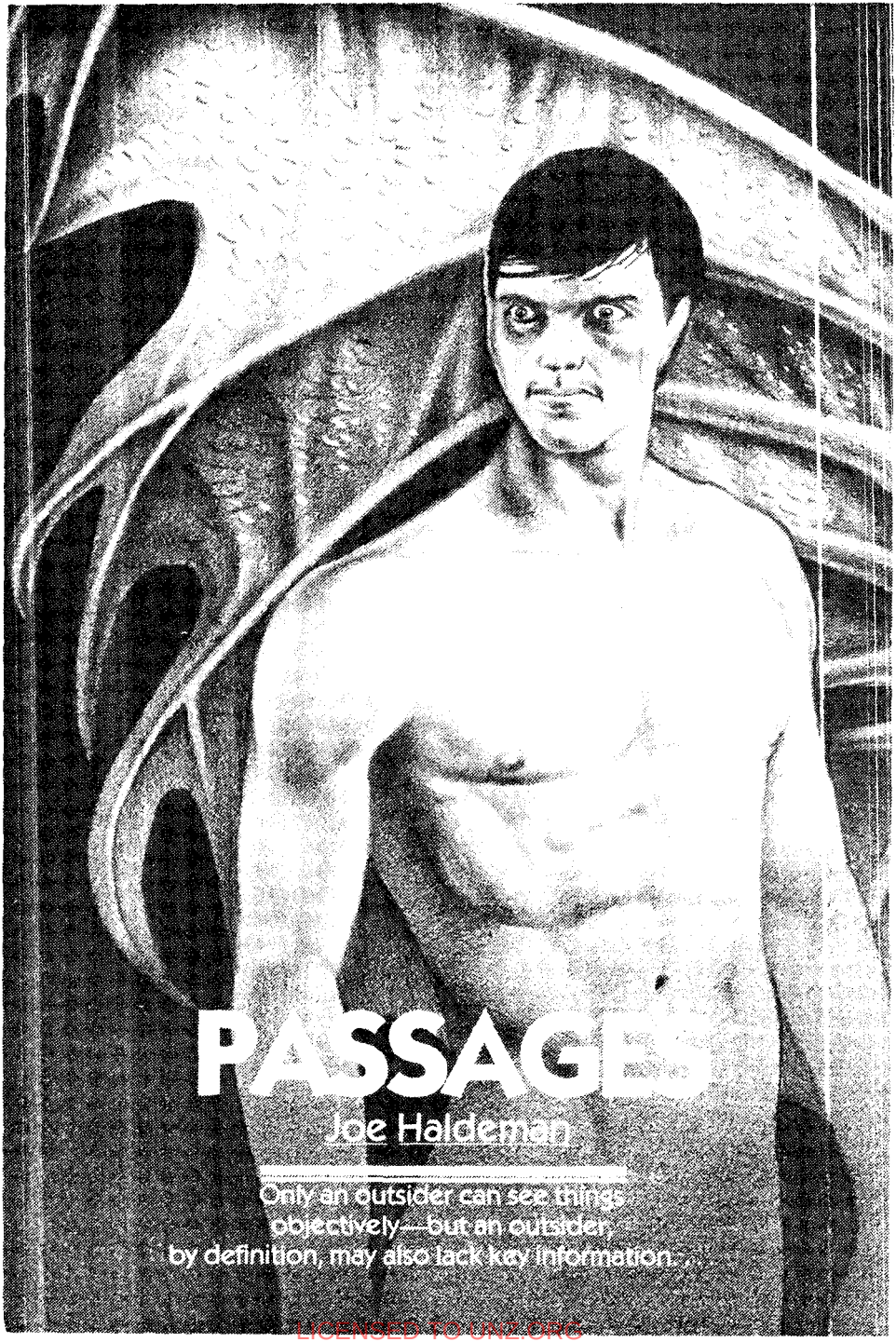
PASSAGES
Joe Haldeman
Only an outsider can see things objectively—but an outsider, by definition, may also lack key information...

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Life begins in a bloody mess and sometimes it ends the same way, and only odd people seek out blood between those times, maybe crazy people. I feel that way now. But the first half of my life ran with blood, most times animal blood, sometimes human. I was a certain kind of hunter's guide.

In those days I didn't have an office on any planet. Not in the sense of a physical place to meet clients. The character of the place where a client asked to meet, his home or otherwise, helped me decide whether to take him on. And the way he dressed, spoke, held himself. It's a special sense, a gestalt. If you took on every darf who had the money you'd wind up dead, and him too.

It almost always is a "he." There are more women than men with money, but to want to hunt, you need that instinct to point at something and squirt it.

Raj Benhaden III had picked a good meeting place, a milk bar where the young serving women wore face veils but nothing substantial from collarbone to ankle, and where wine was available for infidels like me. But he didn't otherwise make a good first impression. He surged through the beaded door curtain, a large muscular man with a looking-for-trouble expression, scanned the room imperiously, nodded at a signal from one of the women, and then stomped over to my table with the chunky gracelessness of the overtrained athlete. His first two words:

"You're white."

"So was my mother."

He nodded at that revelation and sank into a chair. "You don't look like a hunting guide."

"You don't look like a prince."

"Really. What do I look like?"

Time enough for tact later, if I decided to take the job. "You look like a midclass man who was on the team in school. Say, fifteen, twenty years ago. Now you spend a lot of time in the gymnasium. Trying to turn the clock back."

He nodded again, staring. "Slow it down, anyhow."

A beautiful houri floated over with a glass of mint tea. He took it without appearing to notice her. "A cousin of mine from Earth engaged you last year. He recommended you, so I looked up your listing in Registrar Selva. You've worked a lot of places."

The only Earthie I'd guided in a year had almost been the end of me. Crazy man. "M'suya was your cousin?"

"M'suya." He smiled slightly. "Don't worry. The rest of the family is almost normal."

"I've never been hired by a normal person. Normal people don't seek out the company of dangerous animals."

"A point. Selva says your specialty is trailbreaking, taking hunters and collectors to new places."

"Which is why your cousin hired me." We'd gone to a planet called PZ1439, too new even to have a name. "But I prefer to know at least something about the place, the kind of creatures we'll be up against."

"This place is not completely unexplored. The creature has been observed a few times." He paused. "The planet Obelobel. I want the skin of a baleseli."

"I don't know the animal. Think the planet's closed, though."

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"The animal is worth the trip. And I can take care of the quarantine. What do you say?"

It sounded OK. "I'll have to do a little research—"

"No. Decide now."

His eyes were actually glittering with excitement. "Sure. Leave as soon as you put the fix through."

He stood up. "Tomorrow." I watched his large back sail away.

Rich people always leave you with the check. His mint tea was still steaming, untouched. I tasted it; too sweet. Sipped the wine slowly, appreciating the women, thinking it would be a while before I saw another. If only that had been correct. The next woman I met would turn out to be less pleasant to deal with.

As expected, two drinks' tariff would have bought a good meal on Selva; a banquet on Earth. Raj would pay it back a hundredfold.

I liked working from Qadar, though your daily expenses are the size of some countries' budget deficit. They pay you twice as much as elsewhere, with no argument. And they have a good library. I went back to the Hilton to punch it up; find out what was known about Obelobelians and the baleseli.

Obelobelians are weird, which is no distinction among alien races, and the baleseli is about a hundred kilograms of bloody murder that leaps out of the night. I began to have qualms.

It's a twelve-legged, eyeless (sonar-ranging) creature about twice the size of a human, which is to say about three times the size of an Obelobelian. The six legs on either side are joined with leathery membrane, like the wings of a terran bat. On the inner surface of the wings are tens of thousands of stiff curved cilia: tiny hooks. It kills by enveloping the prey and ripping its skin off in one swift jerk.

It doesn't have a true mouth. While the prey is still twitching, a slit opens up along half the length of its thorax, ventrally, from the base of the tail to the middle of the chest, and its stomach everts, rippling up over the hooks (which all point outward) to enclose and seal off the dying, flayed animal. Strong acids and enzymes digest the meal in about fifteen minutes, during which time the baleseli is theoretically helpless. It leaves behind a compact husk of undigested hair, bones, and nails, and perhaps corroded jewelry.

You could think of worse ways to die, but it would be a short and disgusting list.

The Obelobelians have a rite of passage, which had been seen only once by humans at the time, that involves going into a cave and offering yourself as food. The baleseli evidently knows what eyes are; it only attacks from behind. You evidently have to sense its approach, turn quickly, and impale it. A test of the hunter's, or soldier's, sixth sense—which I hoped was highly developed in the ruling class of Qadar.

The caves where the beasts live typically form clusters of interconnected hemispheres, each the size of a large sports stadium. During the day, the baleselis cling to stalactites at the tops of the domes. They usually have to go outside to hunt, at night, since few large creatures are stupid enough to wander into their lairs. Their normal prey are

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young and old strays from the herds of saurian egg-producers that accompany the Obelobelians on their seemingly random migrations around the planet's one continent.

The Obelobelians use the rite as part of a ruthless simple form of population control, sensible on such a barren planet. No one goes through the rite of passage until someone has died. The next night, a young native goes into the cave; he or she comes out sexually mature, and immediately mates with a predetermined partner. A female mates only once in her life, but always has multiple births. The number of offspring she will have, they say, depends on how many die in the rite of passage before one makes it through.

The baleseli kill about half of the youngsters who go into the caves, but don't bother the natives otherwise, though they sleep unprotected, not having invented the roof. The baleseli haven't bothered the humans yet, either, a few dozen xenologists who perforce also sleep under the stars, though perhaps not as deeply as the Obelobelians.

The three-week trip was uneventful. Raj Benhaden III was unusually reticent for a Qadarem. Their planet doesn't have much commerce beyond the exchange of knowledge, and that exchange is normally quite vigorous. I spent a couple of months on Qadar once, helping set up a xoo there, and you couldn't say one plus one equals two without getting some discussion. A world full of theologians and philosophers.

But Raj was a throwback; he admitted as much in a rare spate of conversation. Most Qadarem are vegetarians, and hunting (as opposed to live collecting) is almost unheard of on the planet. He offered no explanation for his aberration. No, his father didn't hunt. No, he had no philosophical justification for it. No, given a choice in the matter, he didn't eat meat. Yes, he had killed men, in war.

(This we had in common: we had both spent a year of our youth playing at mercenary, on the planet Hell. He did not elaborate, but I got the impression that he hadn't enjoyed the experience much more than I had.)

I couldn't get him to argue about anything, so I pretty much retreated to my books, and he to his body. He had a training chair loaded with weights and springs and pulleys that he could use to isolate any particular muscle and torture it into prominence. A harmless enough compulsion under normal circumstances, but with an ominous aspect here: physical strength was probably going to be irrelevant, since the Obelobelians who went through the rite of passage were as weak as ten-year-old humans. With every bulging muscle, Raj was building up false self-confidence.

When I pointed this out to him, he just nodded amiably and went on sweating.

We came out of orbit to a cloudy spring day, indistinguishable from a cloudy summer-fall-winter day. The planet has a circular orbit and no axial tilt, so no seasons, and the sky is always a uniform thin mist, so no weather. Unless you count heavy dew every night as weather. A gray moldy planet in its large temperate zones, with a lot of caves and a breathable, but unpleasantly musty, atmosphere. The ground was a

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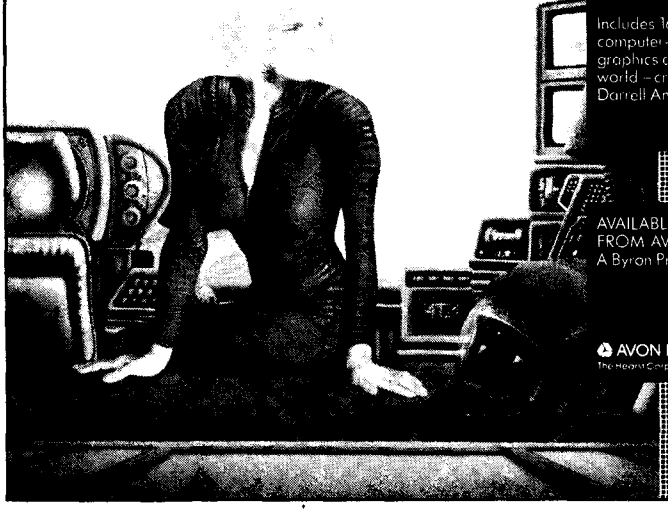

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tangle of presumably inedible mushrooms. Our floater homed in on the silvery dome of the Confederación's headquarters; slid through the force field and landed.

I hadn't expected trouble with the local bureaucracy, since the planet had no humans other than the xenologists. As luck would have it, the woman in charge recognized my name.

"Gregorio Fuentes," she read off the first page of the grant. She dropped it on the small folding table and stood up. She looked like she wanted to pace, but the tent wasn't really big enough. So she contented herself with adjusting the heat under the teapot. With her back to us, she said one word: "Poacher."

"Come on, now," I said, "You can't poach where there's nothing to hunt."

"Oh, just in spirit." She turned and looked at us tiredly. "I assume you're interested in the baleselis."

I tapped the folder. "It's all in here."

"Marvelous creature," Raj said.

"Any xoo would pay a fortune for one," she said, her expression not changing. "But you can't have one."

"Nothing could be further from our minds."

"I'm sure." She poured three plastic cups of bitterroot and served us. "I mean you really, physically, *can't*. You're ten or twelve years too early. No individual can be culled until we have a population estimate. And there's no way in hell you can sneak one up to orbit; they're just too big."

Bitterroot is a special taste I have never acquired. I sipped the nasty stuff and tried to keep my voice pleasant. "The grant is quite clear on that. I'll be collecting some common smaller species that may eventually wind up on display. No baleselis."

"We merely wish to observe them *in situ*," Raj said quietly.

She stared at him and then at me. "I see. Thrillseekers."

"Not at all." I picked up the folder and offered it to her. "Our credentials are in order."

She ignored it. "I'm sure they always are. There's never any shortage of hungry universities. Or bored rich people."

Raj smiled at her. "I have never been bored in my life."

"Then you've never been a scientist forced to push government papers around." She snatched the grant and riffled through it. "I'll go over this in detail tonight. If you've dotted all the t's and crossed all the i's, you can leave the dome in the morning. You understand the quarantine procedure?"

"Of course."

"We'll be watching you every moment. No human artifacts. You go out there completely naked. One wristwatch, one *pencil*, and I'll have you confined until the next Confederación inspection team arrives. That will be a long time. Understand?"

"Yeah. But why not cooperate with us?" I said. "The sooner we . . . complete our research goals, the sooner we'll be a memory."

"Your *research* could be a disaster," she said, her voice starting to shake. "The Obelobelians are the most primitive alien culture we've ever encountered. Perhaps the most primitive that ever *will* be encountered. We have to proceed with extreme caution. Just the fact that we have to communicate with the Obelobelians contaminates the very

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data we seek. And we are highly trained, dedicated, and *careful* researchers. Anyone else who comes in contact with them is a wild card."

"We won't try to sell them any trinkets," I said.

"If they had money, I suspect you would." She stood up. "I'll contact you in the morning."

I thought the quarantine restrictions were ridiculously tough and also hypocritical: the Confederación's presence was marked by a shimmering silver force dome over a hundred meters in diameter, with floaters almost daily dropping out of orbit and returning. The natives might notice.

Dr. Avedon was not happy with our knives, but couldn't confiscate them. They were both genuine Obelobelian artifacts, razor-keen chipped crystal, "on loan" from Selva's Museo Arqueológico. I needed mine to make cages. Raj needed his to make a spear.

I was going into the cave with him, but not as a combatant. The baleselis supposedly would ignore you if you keep your back to the wall, and that was exactly what I intended to do. Unless Raj got into trouble. Then I would help him—if it looked like it would do any good—but my fee would be quadrupled. Raj agreed to this with the easy confidence of a man who lacks the imagination to picture his own death, or who simply holds death in contempt. I never got to know him well enough to figure out which.

Even after we were allowed out of the dome, we had to spend a day in preparation. I had to weave the equivalent of rucksack and canteen out of local materials. A xenologist on Selva had showed me how—but it's one thing to duplicate a primitive craft under controlled conditions, with the help of an experienced tutor, and quite another to go outside and hack down the materials and try to do it from memory. The first half-dozen canteens I wove would have made decent colanders.

I gave up trying to work outdoors. The cold didn't bother Raj—Qadar is no tropical paradise—but it made my fingers numb and clumsy. Finally I pieced together two rucksacks and four liter-sized canteens. We rested and set out at first light.

The map I'd memorized didn't do much good. No compass and no sun, just uniform dull gray from horizon to horizon. Fortunately, it was easy to follow the trail the scientists had made, a conspicuous path of crushed fungi.

It was certainly the most depressing world I'd ever seen. The scenery was like the magnified surface of a diseased organ. The dominant form of fungus was a sort of mushroom with an inverted cap, like a bowl, always full of scummy evil-smelling water. Pasty white with streaks of brown and gray. The only green in the landscape was an occasional stand of bamboo-like grass, which had provided the material for my weaving and Raj's spear shaft. It was a sickly mottled chartreuse of a green.

Also slightly green was the fungus that began to grow on us after about an hour, a slick powdery fungus that crawled out of armpits and navels and the moist crease between scrotum and thigh. It looked bad enough on my olive skin, but on Raj, whose skin was so black as

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to be almost blue, it was spectacularly ugly.

(It's very strange for an alien life form to find humans amenable as hosts, or food. Because of divergent evolutionary patterns, we're usually incompatible at the level of DNA. We'd discussed the possibility that the baleselis would turn up their noses, if they had noses, at Raj. In that unhappy case, I would get a "no-kill fee," equal to one third of the standard guide's fee.)

I'd made my rucksack twice as large as Raj's; it was actually a double-compartmented cage with carrying straps. We both kept our eyes sharp for specimens, and we couldn't have missed much. Anything that twitched on that moldy mausoleum of a landscape would have stood out like a live bug in a plate of cold spaghetti. We went all day without seeing anything, though, which was boring but not surprising. Most of the loathsome creatures who crabbed or slithered through the toadstools were nocturnal. I was sure there would be plenty of them around when we were trying to sleep.

We didn't talk much during the trek. I tried to start conversations a few times but Raj damped it with monosyllables. So I was sort of relieved, looking for some human contact, when we came over a small rise and saw the archeaologists' encampment. It was a well-tramped circle a couple of hundred meters from an Obelobelian "village," which was just a scatter of belongings and shared fires. About a dozen of the skinny pale horse-sized dinosaurs that the Obelobelians followed around, the tytistu, grazed mushrooms or slept standing up. A thin man with a white beard walked up the path to meet us.

He didn't look happy. Before I could introduce us, he said, "You're the adventurers. Fuentes and Benhaden."

"You're in touch with Dr. Avedon?" I said.

He opened his mouth and pointed to a molar. "Radio. She says your accreditation is in order and we are not to hinder you. Nor cooperate, you might as well know."

"Which is stupid," I said, regretting it but forging on: "Your own project's funding can only benefit from our visit here. There will be publicity."

"Publicity to bring more thrillseekers. We're trying to do *science* here, Fuentes; it's not a freak show." He turned and walked away. That was the last word we heard from any scientist, until they came up the hill to help me with Raj.

We made our "camp"—putting down our rucksacks and kicking away enough of the disgusting undergrowth to make sitting space—just downstream from the scientists' and Obelobelians's camps. The river, wide and shallow, barely moved. The water was grey and smelled like stale cheese. We followed the xenologists' lead and gathered our water upstream from the Obelobelians. We weren't likely to catch any disease from alien pollution, but it did sometimes happen, usually with fatal results.

Raj settled in to make a few backup spears while I went off in search of a good cave. I didn't want to antagonize the scientists by spending too much time talking to the Obelobelians, contaminating their precious data, so rather than

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ask directions I just followed a conspicuous path that led toward likely-looking hills.

The hills were rocky, inhospitable to the mushrooms; the only vegetation was lichen of muted earth hues. I did find animal life, though, kicking over rocks. Small invertebrates that resembled Terran millipedes, mainly. Not worth collecting and possibly biters.

There were plenty of caves, but it was some time before I found one large enough. All of them probably led to the baleseli domes, but I wanted to be able to exit standing up and moving fast.

When I found a large enough entrance, I shed the rucksack and went in with just the knife. Like Raj's, my knife was a slight violation of technological quarantine. It truly did come from Obelobel, but had made a couple of stops on the way back. I gave the handle a sharp twist and the end of it popped open, exposing a small powerful flashlight.

The baleselis supposedly slept during the day, but my experience with large dangerous animals had led me not to put too much trust in established behavior patterns. Besides, the cave could harbor smaller perils. Its terran counterparts might be havens during the daytime for rattlesnakes or scorpions or vampire bats. So I entered very tentatively, literally one step at a time, my eyes fixed on the darkness, knife ready and light beaming forward. It was easy to visualize what I must look like to any cave dweller: a dangerous hulking silhouette with one gleaming eye. Most animals confronted with the unknown will either run away, seek refuge in shelter or camouflage, or attack. I wanted to give everybody plenty of time to exercise the first two options.

The cave entrance took a sharp turn to the left and began angling down. I waited at the corner, light off, for several minutes while my eyes became better adapted to the dark. There was a constant tattoo of dripping condensation echoing from the chamber ahead, and the downhill path I stood on was dangerously slick. The fungus odor of the air outside was mixed now with a surprising earthlike cave smell of wet rock, along with an acrid metallic tang I couldn't place. It was cold.

I turned on the light, careful not to look directly at it. The downward path continued on for some fifty meters, widening all the way, ending in a ragged square of blackness that I assumed was the entrance to one of the domes.

I have never liked cave work, but Raj was paying well for me to overcome my aversion. Keeping my naked back pressed cold against the wall, I worked slowly down toward the deeper darkness.

The domed cavern was too large for my light to reach to the other side. In the center was a black lake, evidently shallow, since ghostly fingers of stalagmites broke the surface here and there. The surface was constantly in motion with the widening, intersecting circles of ripples from the water that dripped from above. I suppose it was pretty.

Using the trick of averted vision, I could just make out some details of the cave ceiling. What I saw turned my blood colder than my freezing skin. Nestled among a matrix of stalactites of various sizes were dozens of black shrouds, baleselis in repose. They shifted

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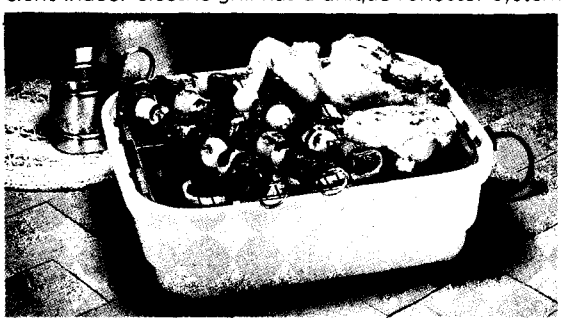

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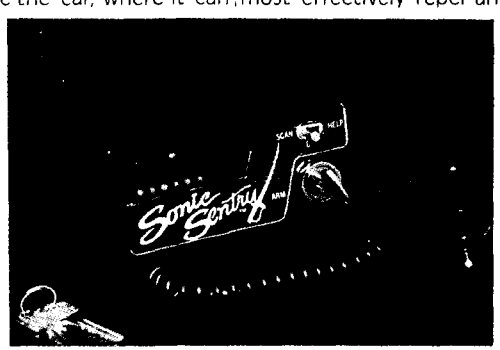

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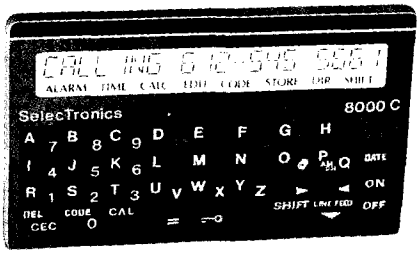

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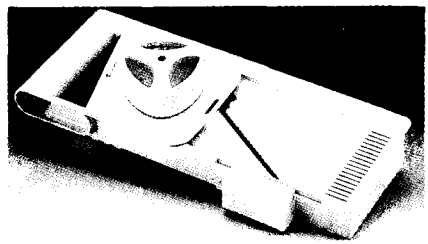

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and flapped languidly in their sleep, perhaps reacting to the intruder below. An imperative buried deep in my reptile brain was trying to persuade me to evacuate my bowels and run. I forced myself to study the scene for a minute or so, trying to visualize Raj standing there with his torch and spears. It looked very bad. If several of them took an interest in you, it was hard to see how you could survive. But every native did go through this, and enough lived to perpetuate the species.

I backed out very slowly, my own fear-smell sharp in my nostrils. I doubted that any animal on this planet would interpret the odor correctly; it might even signal to them that I was poison or at least not food. Raj might have that in his favor, if he was human enough to sweat fear.

I was still somewhat shaken by the time I returned to camp. I almost tried to talk Raj out of it, even though the no-kill fee would only cover my time and expenses.

"They are only animals," Raj said. "We were given dominion over them."

"Don't feed me religion. We're animals too—animals with sharp sticks, granted—but there are dozens of them, and only two of us."

"One of us. I don't expect you to interfere." He nodded toward the Obelobelian camp. "What they can do, I can do."

"We don't know that. Maybe they have some magic word that turns the beasts into obedient puppies."

"That may be." He laughed politely and returned to his chores, spearmaking and fire-maintaining. He had borrowed, or taken, some fire from the Obelobelians, and was feeding it the way they did. A circle of uprooted fungi surrounded the flame; once dry, it burned about as well as dried animal manure, but smelled worse. Fires were started with kumali, a morel-shaped fungus that was a staple of the native diet. They were so saturated with vegetable oil that, skewered, they could be used as torches. He had collected several.

He was making backup spears out of the bamboo-like stalks. Sharpen the green wood and then blacken it in the fire; anneal it by quenching it in the wet ground; resharpen and start over. After a few iterations you had a black splinter that might spit a baleseli. Or might just annoy it, if you didn't hit it just right.

"Plan to aim for the heart?" He grunted uninformatively. "Or the brain—the brain would be good, if it's not behind too much—"

"Enough subtlety. I understand."

"Well, just how do you plan to kill a large animal with a spear, not knowing where any vital organs are?"

"I don't have just *a* spear." He hefted his heaviest spear, the one with his knife lashed on the end. "This should stun the creature no matter where I hit it. Long enough for me to pierce it with several others."

"And hope one of them—"

"Yes, hope."

"And hope none of the other beasts—"

"Yes, *hope!*" He turned his back to me and resumed work. I watched him for a couple of silent minutes.

"I feel as if I've been hired to preside over an elaborate suicide ritual."

"The first part, you have right. You *have* been hired." He turned around and

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looked at me, scowling. "And you don't say that to a Qadarem. A man may give his life. But not take it."

I knew that. "It is suicide. If I have any instinct about animals."

"That may be your problem, Fuentes. Too much instinct about animals, and not enough about humans." He stood up and gathered a few spears. "But you are a good guide. Please guide me now to see these monsters."

Since I didn't have to search for the place, we got there in a brisk twenty minutes. I led the way inside. Raj followed my instructions, making slow progress for dark adaptation as well as caution, but his impatience was palpable.

When we got to the dome we both stood against the wall for several silent minutes, studying. With the extra flashlight, I could see that my estimate of a few dozen creatures was far too small. Hundreds of them crowded the high ceiling. With the extra light I could also make out considerable variation in size and color. Most of the large ones had glossy black shrouds, but the smaller ones—some as small as a human infant—were mottled or even striped in what seemed to be subtle shades of red and brown. Of course colors are elusive at low light levels.

"Still want to go through with it?" I whispered. "There's enough up there to take care of that whole tribe and go away hungry."

"They must not eat often," he said, "for this barren area to support so many."

"Maybe that's why it's so barren. They killed everything bigger than a mouse."

He snorted. "You don't believe that. There must be ecological balance."

"Not in the short run, there doesn't. Not even in the long run, if we're witnessing a basic evolutionary—"

"I know what it is. Burst metabolism. Large reptiles on my planet have that. They lie dormant for days, or even weeks, until something large enough to be worth eating comes close enough to catch. Then they move with great speed, for a few seconds."

"That's not unreasonable," I had to admit. "I suppose you've hunted them."

"Oh yes." He was smiling, staring upward, white teeth and eyes glowing almost disembodied in the darkness. "Bare-handed." Abruptly, he stepped away from the wall, going about halfway to the water's edge.

"Raj!"

"Shouldn't be anything to worry about," he said, far too loudly for my comfort—and then he *shouted* several words in Arabic. When the echos stopped chasing around the dome, there was another noise: the beasts' wings rustling in reaction.

"Christ—you're waking them up!"

"Maybe one or two." He threw a spear straight up and stepped back to the wall. "I'd like to see them fly."

The stick slowed and began to tumble, and barely brushed one of the large ones. It stretched its wings, dead white inside, and let go of the stalactite. The stone column thrummed a deep bass note. The creature fell slowly, parachuting, and about halfway down beat its wings hard several times, hovering and then climbing back up to its perch. It grabbed the stalactite and folded itself around it.

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"Not too fast," Raj said.

"Not awake yet." I was impressed by its grace and evident strength. "Let's get out of here."

"All right. And come back tonight, with torches."

"Unless you have an attack of sanity." If I hadn't been there, I suspected Raj would have just turned his back on them and walked straight out of the cave. But he obediantly mooched crabwise along behind me.

Waiting at the cave entrance was a group of four Obelobelians, perhaps a family. Mature male and female, a tall host, and a child who didn't yet have any visible sex. All of the adults wore short black cloaks, made of hide from the baleseli's wings.

I greeted the host—the other genders never spoke with humans—and it returned the formal politeness but moved to block our way.

"Not night," it said.

I agreed: "Not night."

"Baleseli sleep?"

"Yes."

"Baleseli growing ritual, you?"

I put my hand on Raj's shoulder. "Him, tonight."

"Not young, him."

I thought for a second. "On his world, young."

It considered that in silence and slowly stepped aside. "Tonight."

They let us get about fifty meters down the trail and then followed in silence. We stopped at our fire and they walked on by as if in a trance. Of course, they were probably gossiping, joking, philosophizing like mad—telepathically.

At that time, the scientists were still looking at the Obelobelians as innocent flea-picking primitives, barely social, pre-agricultural and so forth. Language limited to a few hundred words, mostly nouns and adjectives. As we later learned, only the hosts use spoken language, and before humans came, they only used it in ritual. One spoken word drowns out real conversation for minutes, echoing in their minds. Active verbs are the "loudest," so they avoid them.

I spitted a few mushrooms and roasted them over the smoldering lumps. The four days' food we'd brought cost more than the expensive knives. It took some delicate bioengineering to make mushrooms that looked like the vile things the Obelobelians ate but were nutritious to humans, and at the same time not poisonous to Obelobelians, just in case they took a bite. You couldn't ask for flavor on top of that. Filet of sock.

Raj seemed to enjoy them; he ate his three and then roasted another pair. Being vegetarian might have helped. Looking forward to the evening, rather than dreading it, certainly did.

One last try. "There's no way we're getting off this planet with a baleseli skin," I said.

"Leave that to me."

"What, you think you can bribe Dr. Avedon?"

"No. Though I'm sure she has her price." He picked threads of flesh off the outside, saving the best for last. "If she's still the only person in the dome, it's simple. She has to sleep. I leave the hide outside the dome until she does."

"Word of the kill may precede us."

He shrugged. "At worst, they throw us off the planet, I pay a fine, I don't get to keep the skin. That's all right."

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"And I pay a fine, too, and lose my license."

"As we discussed. I'll compensate you."

"If you're alive."

"Even if I'm not." True enough; on Qadar, his family would assume responsibility for his debts. "Well. Look at this."

I turned around and saw a group of Obelobelians approaching. A tall host with a cloak, maybe the one we'd encountered at the cave, and eleven females armed with spears.

I spread my hands and spoke to the host. " Padafat oté tekanen?" I asked; what's up?

It spread its hands the same way, but with two more fingers. "He cannot . . . *do!*"

"But he is young. He desires passage."

The host pointed at Raj's plumbing. "He is, he *has* passage."

"No," I said. "On his world, like mine, even young boys have that. Males are born like that." An Obelobelian's genitalia stay hidden until the rite of passage. Apparently the shock triggers a basic anatomical change—sort of like getting the stuffing scared out of you. (If you could believe what the Obelobelians told the scientists, that is. They wouldn't be the first autochthons to hide a sly sense of humor.)

The host turned its back on me and sat down. Two of the females sat down facing it. The other nine stared at us, rigid with discipline or fear or boredom.

"Do you think—" Raj began.

"Hush." He nodded. Probably not a good idea to interfere with the ritual.

After a few minutes the host stood and turned back around. The expression on its face would have been chagrin on a human's. He pointed at Raj. "You are die."

Raj was holding one of the fire-annealed spears. I saw his grip tighten. The host slouched and walked back down the path, along with the two it had been sitting with.

The other nine guards stayed, unblinking. Then they stepped forward three steps in unison, toward Raj, ignoring me. The one closest to Raj made an unmistakable gesture, pointing at his spear and then holding her hand out, palm up.

Raj's tone was pleasant and he smiled. "There is no way in seven hells I will give you this spear." She repeated the gesture.

"Better hand it over," I said. "Nine against two is no odds."

He looked at me. "Nine against one. You do what you will."

The guard very slowly wrapped her many fingers around the weapon's shaft. Raj watched the action in a calculating way. He would certainly win any contest of strength. With her other hand, though, she offered Raj her own spear.

"I'll be damned," I said. "She wants to trade."

Raj studied the heavy flint tip, the careful binding that fastened it to the wood. "Not much of a trade." He relinquished his and took the shorter, stronger weapon. "Thank you."

She put her palms together in an all-purpose social gesture and I told Raj to copy it. Then the nine of them ambled back toward their camp. The one who had made the exchange tossed Raj's spear aside.

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"I would regard that as an omen of good fortune," Raj said.

"Acceptance, anyhow."

In retrospect, it seems odd that we didn't realize they were using telepathy. It had not at that time been demonstrated, although a form of it had been suspected for years in the case of the S'kang, of the carbon star Ember. But these creatures seemed so feckless and primitive.

For the next couple of hours we each rounded up bundles of the kumali torches and I improvised holders out of the soft domed tops of the largest fungi—that way we could have several of them burning in the cave and still keep both hands free, for spears.

"What are you going to do if they ignore you?" I asked.

"What do you mean?"

I shrugged. "Suppose the baleseli need some sort of olfactory clue to attack. Or suppose there's some gestural stimulus that young Obelobelians do instinctively."

"In that case, I suppose we'll have to wait until some native goes in for the ritual. If we follow along, we should be attacked as well."

"That could be a long time. What do you propose we eat, waiting for one of them to die?"

"Accidents happen."

That was too much. "I won't be an accessory to murder."

"I didn't say murder." He looked up at the slate sky. "Getting dark."

He was right, and I felt a sudden easing. I hate the waiting around before going into action. What's going to happen will happen, and worrying about it never helps. "Let's go."

I bundled up all of the small kumali torches and the improvised bases, and carried them under one arm, with a lit one in the other hand awkwardly gripped along with the knife, and a canteen hanging from a vine around my neck, bumping with every step. I think humans invented clothes so they could have belts and pockets.

Raj looked slightly more dignified, only slightly, with a bundle of fire-hardened sticks under one arm and the two flint-tipped spears in the other hand. We didn't look like any match for a cross between a manta ray and a vampire bat.

The Obelobelians were waiting for us: the old host, the female guards, and a couple of males, unarmed and smaller than the females.

"Came to wish us luck," Raj said.

"Sure." I approached the elder and lay down my bundle. Before I could deliver the standard greeting, it pointed at Raj again. "He is die," it said.

Well, it hadn't turned out to be a threat last time. A curse? A prediction? "And me?" I asked. "Am I die?"

The host stared at me for more than a minute, with a weird hunched intensity. (Now, of course, I know that it was trying to break through the static in my mind so we could really communicate.) It took a step forward and rolled its shoulders like an exotic dancer, *very* exotic, which I supposed was an Obelobelian shrug. "Not maybe, die maybe. It is . . . self. You must be . . . self." Always good advice. Go forty light-years and find Polonius.

"Why are you here?" I asked.

The shrug again. "Always be for a passage here, there. Where passage be."

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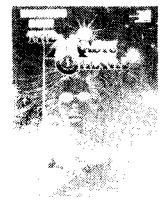

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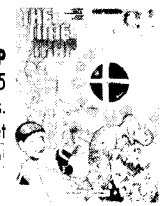

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"You may be right," I said to Raj. "Just a cheering section." Or pallbearers, I thought and didn't say.

No one tried to interfere as we walked into the cave, and no one followed us, at least not immediately. Best not to use the flashlights, in case. Raj hadn't wanted to, anyhow—trying to duplicate as nearly as possible the native experience—but that was a quirk I would not let interfere with my survival, or even his.

Raj followed the game plan all the way down to the main cavern. We hugged the side of the cave, moving as quietly as possible. With every tiny click of a pebble, though, I felt exposed. Hard to sneak up on a blind monster that feeds by sonar.

As we squeezed into the last cavern we startled something big and white and shiny, like a maggot the size of a horse, that slid into the water and squirmed away. Wings rustled overhead.

After a moment of paralysis I mastered my fear enough to begin lighting torches. Raj took two and sidled ahead of me, both of us keeping our backs pressed against the gritty wall. We worked backward and forward and soon had a staggered line of sixteen greasy big candles guttering in the still air.

There was enough light to see each other clearly, and I didn't care for what I saw. Raj was grinning so hard I could see both rows of white teeth in his black face, and if he was feeling anything except pure ecstasy, he was hiding it real well.

I've seen it before, of course; men getting an almost sexual thrill from the prospect of facing a dangerous animal. It's sort of amusing when you're protected by laser rifles and body armor. Not so amusing when you're naked as babies and armed with sticks and rocks. Sort of insane, actually, and I had to admit considering for the first time in a long career abandoning a client for fear he was determined to get me killed. I stayed, of course, and shouldn't have been surprised at what happened next.

I didn't actually see Raj make his move, since all my attention was concentrated on the cave ceiling, searching the murk for the humped forms of the baleseli. I couldn't see them yet, though, my eyes still dazzled from lighting and placing the candles. I wonder even now whether Raj could see more than I, or didn't care, or was tired of waiting—or did feel the same fear I did, and dealt with it in his own way.

Whatever it was, I heard a sudden shout, almost a bark, and was appalled to see Raj halfway to the water's edge, a spear in each hand, bellowing a challenge into the gloom. He was answered: a silent wisp of dark umber against the cave's blackness, suddenly behind him, drifting in at eye level—I started to shout but he had sensed it, spun around, hurled the right-hand spear with perfect accuracy. The spear struck the beast dead center with a meaty smack, and it suddenly reared back, tripling in size as its huge wings unfurled, beating the air. The teeth inside the wings glittered like thousands of diamond points. Then the other spear hit even harder, not ten centimeters from the first.

The baleseli made a strange high-pitched sound, unlike any pain cry I know, but rather like the mating challenge of a ba'albeast on Selva or the chittering of a terran dolphin. Suddenly

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it seemed to contract in every dimension and then spring back to normal size, as if flexing a huge muscle. Raj stood transfixed as the beast did this three times, meanwhile beating its wings to stay aloft. I shouted for him to come back. He ignored me, reaching down to pick up a pair of the fire-hardened sticks.

The fourth time the creature flexed, both of the spears came loose and clattered on the ground. A dark green fluid pulsed out of it as it reared back, hovering now a few meters from Raj, who had both lances braced against his sides, pointed at the beast. Then a second one dropped from the ceiling and enveloped him from behind.

It was hideous. He roared and struggled; twice, lance tips pierced through from inside. Green ichor and red blood sprayed in every direction. Then it slumped away.

For one terrible year, age nineteen, I hired out on Hell as a mercenary soldier. I saw too much, but nothing I saw in that year was as bad as the sight of Raj, face intact but skin flayed off from shoulders to knees, heart and lungs exposed and guts spilling out, uncoiling; beyond mortal help but not beyond realizing what had happened. He faced me and said four clear words—one of them was "Allah" but that exhausts my Arabic—then made a strangling sound and fell over, probably dead, certainly doomed. The creature that had attacked him was writhing soundlessly on the ground. The one he had speared fell flapping, splashing, into the water.

Some basic human, or humane, instinct almost killed me then. I took a couple of steps toward him. A baleseli whispered down between me and the cave wall and enfolded me.

I must not have been in its embrace for more than a second, but that second resonates through my life like a huge bell struck once. I think it resonated backward, weeks, as well as forward, to now and however much longer I have. That's why I had been so jumpy.

Mine must have been larger than the one that killed Raj. It covered me face and all. It was like being smothered by a woolen blanket soaked in animal blood.

I froze. Thousands of tiny teeth pressed gently into my flesh, like the grains of coarse sandpaper but alive. Knife pinned uselessly between my own wrist and abdomen.

Maybe Buddha defeated Allah in this contest. I hadn't been to kiack in twenty years, but the Way lies deep, and in what I thought was my last act as a living being, I tried to compose myself for death. The teeth pressed harder and I surrendered. . . .

And was suddenly spilled out onto the cold wet rock, unharmed.

I rolled back to the safety of the wall, burning my calf on one of the kumalis but heedless of the pain. Calming somewhat, I was surprised to see that the creature seemed not to have harmed me beyond leaving mild abrasions all over, such as you might give yourself by scratching an itch too vigorously.

The one that had attacked me was flopping around as Raj's was; in less than a minute both were limp, dead. Alien protein, of course. There was no way they could sense our toxicity without tasting; evidently one taste was plenty. I supposed the simple creatures

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mistook us for Obelobelians, which triggered the aggressive behavior. The truth turned out to be somewhat stranger.

I hadn't asked Raj what was to be done with his remains, should the hunter become the quarry, but assumed he was conventionally Moslem in that regard. On Qadar the ceremony goes on for days, and a lot of the ritual involves the physical corpse.

It was an interesting problem. I'm conventionally tolerant of other people's notions, and there was the added incentive that Raj's relatives might not honor his debts with only my word that he had died. But there was no way in hell I was going to saunter out there and drag him away. Just have to wait until daylight, when the baleseli were dormant again. He would be a pretty sight in ten hours.

Something touched me on the shoulder and I almost jumped out of my aching skin. It was the old host. "I watch," it said. "He is die; you are passage."

"Guess so," I said. I did kill a baleseli, though the weapon I used was not especially heroic. Sweat.

The host solved part of my problem. It had a long looped cord that ended in a wooden hook. On the third toss, it snagged Raj behind the knee; together we were able to haul him to the wall. Carrying him out was not something I would ever care to try again. It took a long time. The host would not touch him—probably wise—and his dead weight nearly defeated me. I collapsed twice on the passage out, and again as we staggered from the cave entrance. Several of the xenologists were waiting with a pair of improvised stretchers. One of them, an older woman I hadn't seen, touched my arm and I felt a slight pinprick. All the pain washed away and I fell asleep.

I carried Raj back to Qadar frozen solid in a specimen bag. His family paid my fee in gold and had me thrown out of the house, the castle. I decided it would be prudent to leave Qadar immediately.

Odd how things sometimes come together. I had done a lot of soul-searching on the way back, and decided that I had been a hunter for far too long. The fee for this one would allow me to live prudently for several years on Selva or Thelugi, both of which had good universities for xoology and animal behavior. I could finish the degrees I started twenty years ago and stop killing the things that I liked the most.

When I got back to the spaceport there was a Hartford courier waiting for me with a bright red Confederación envelope. It was a message from Dr. Avedon, the xenologist who had been so happy to see me and Raj when we showed up with our phony papers. She said that the Obelobelian tribe they were observing had refused to cooperate with anyone but me, since I was the only human who had undergone the rite of passage. Would I consider coming out to assist them for a regular consultants' fee? She wasn't enthusiastic about having any of her people go into those caves at night, for certification.

I could just see her teeth grinding as she wrote a letter of supplication to Gregorio Fuentes, heartless poacher. She probably knew that the maximum pay she could offer was less than a tenth

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of my normal fee. I would refuse contemptuously and they would be stuck.

Of course I did go back. I stayed on Obelobel for twenty-two years, and still return every three years for a tribal purification ceremony, which will kill me if I live long enough. That honestly is something that bothers me not at all. Not because I'm old or tired of life.

We've learned a lot from the Obelobelians, including humility. The second surprise was telepathy, which we learned through my own initiation as a host-surrogate. The first surprise was from their biochemistry, a discovery that had been in the making when Raj and I arrived there: the Obelobelians came from another planet. Their body chemistry was as alien to Obelobel as ours was—and the baleseli found them just as poisonous. The ones who survived their rite of passage did exactly as I had. The creature's flaying reflex is triggered by its prey's struggling. If you remain motionless long enough for it to reject you, you may live.

It seems cruel, by human standards, to subject the young to such an awful test. But to their way of thinking a male or female is not born until he or she comes back out of the cave; a child killed by the baleseli is a late miscarriage. To be allowed to reproduce you have to show absolute fearlessness. You have to show that you are grown.

So where did they come from, and how, and why? They are not willing to answer such questions. Able, but not willing, and anyone with a grain of objectivity about human nature would have to agree with them.

We thought it was a case of an advanced civilization dealing with childish savages who could think and communicate only at the most basic level. We were right. ■

● 'Tis not knowing much, but what is useful, that makes a wise man.

Thomas Fuller

● Anyone can do any amount of work, provided it isn't the work he is supposed to be doing at the moment.

Robert Benchley

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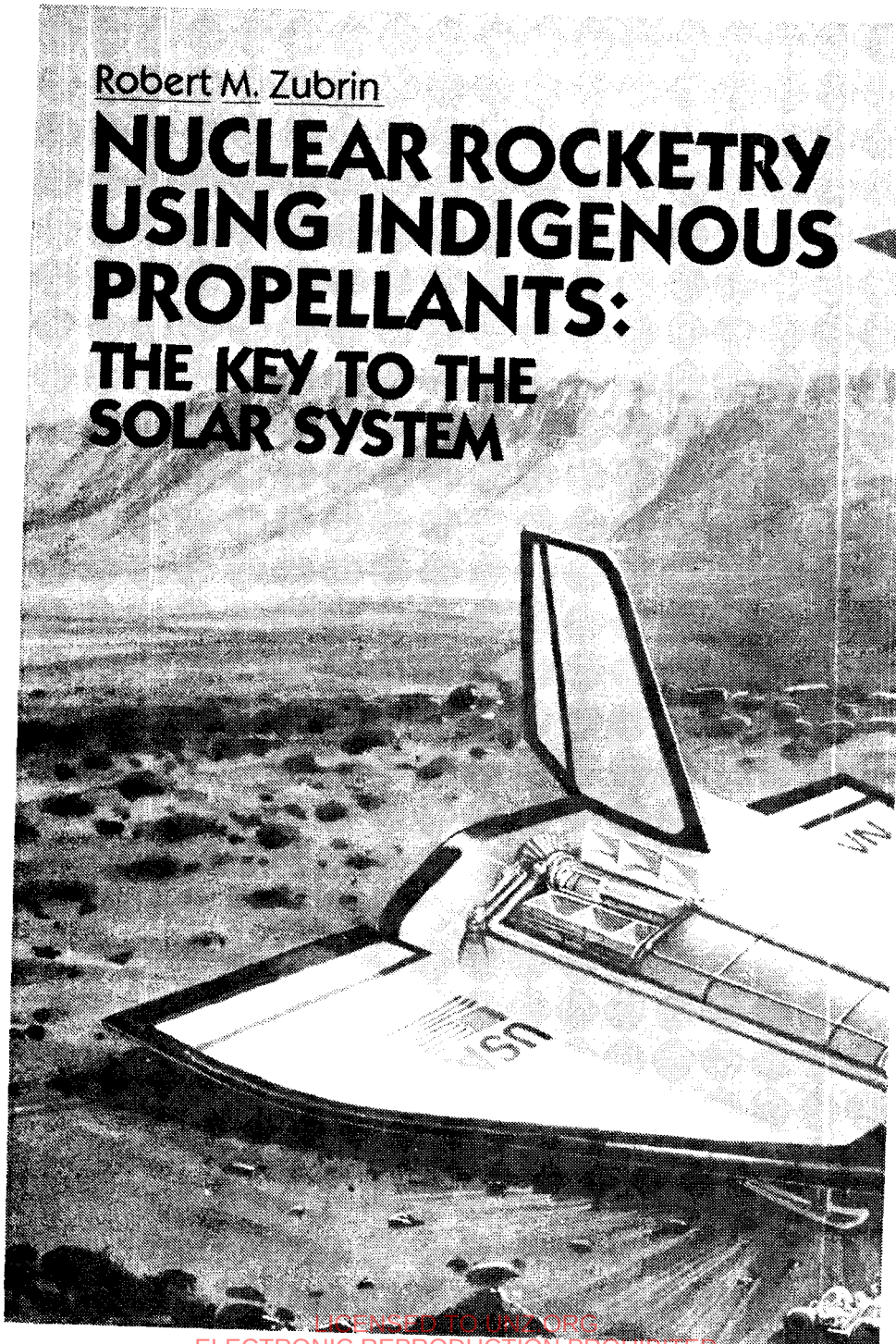
Robert M. Zubrin

NUCLEAR ROCKETRY USING INDIGENOUS PROPELLANTS:

THE KEY TO THE SOLAR SYSTEM



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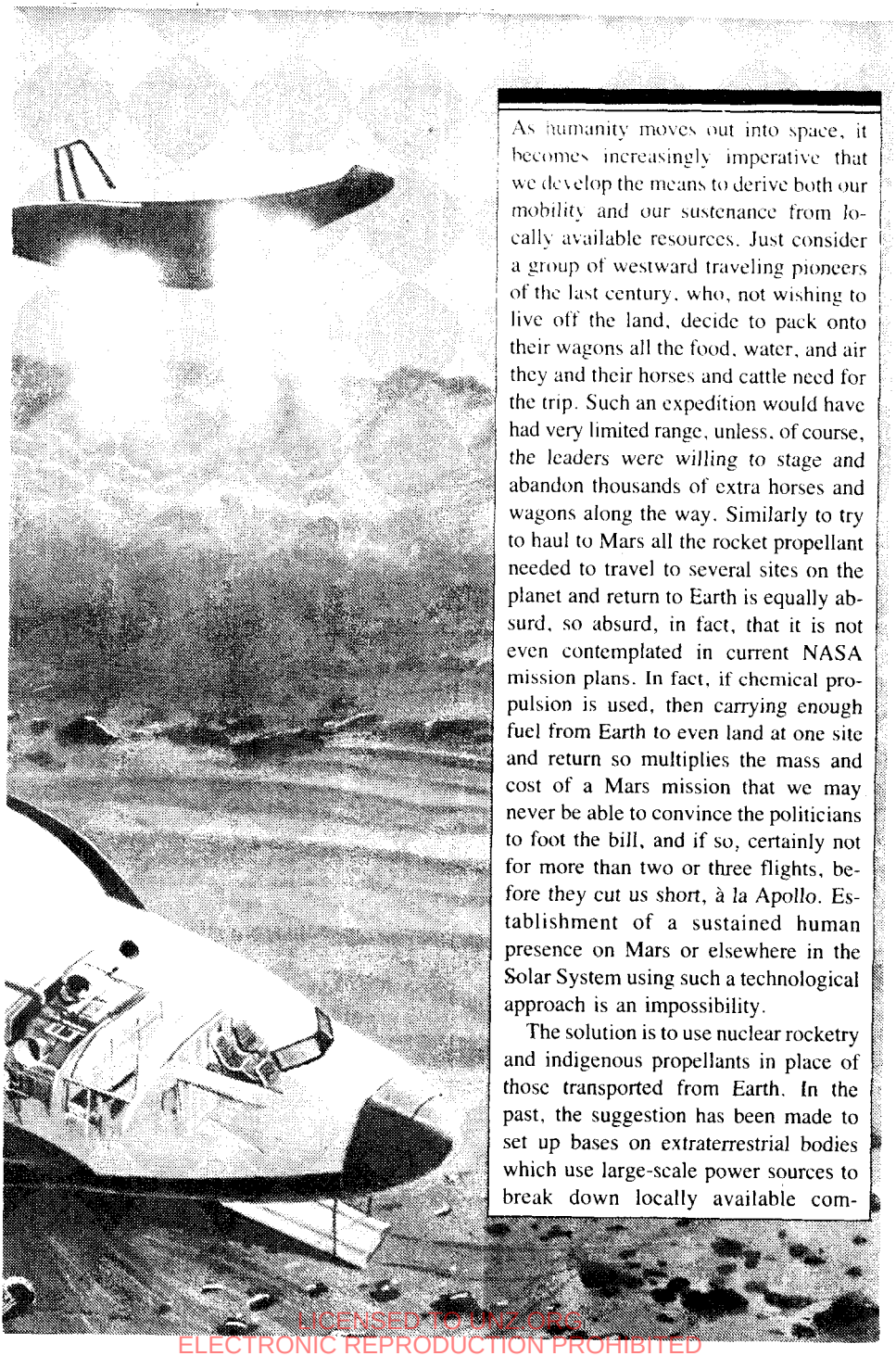

As humanity moves out into space, it becomes increasingly imperative that we develop the means to derive both our mobility and our sustenance from locally available resources. Just consider a group of westward traveling pioneers of the last century, who, not wishing to live off the land, decide to pack onto their wagons all the food, water, and air they and their horses and cattle need for the trip. Such an expedition would have had very limited range, unless, of course, the leaders were willing to stage and abandon thousands of extra horses and wagons along the way. Similarly to try to haul to Mars all the rocket propellant needed to travel to several sites on the planet and return to Earth is equally absurd, so absurd, in fact, that it is not even contemplated in current NASA mission plans. In fact, if chemical propulsion is used, then carrying enough fuel from Earth to even land at one site and return so multiplies the mass and cost of a Mars mission that we may never be able to convince the politicians to foot the bill, and if so, certainly not for more than two or three flights, before they cut us short, à la Apollo. Establishment of a sustained human presence on Mars or elsewhere in the Solar System using such a technological approach is an impossibility.

The solution is to use nuclear rocketry and indigenous propellants in place of those transported from Earth. In the past, the suggestion has been made to set up bases on extraterrestrial bodies which use large-scale power sources to break down locally available com-

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pounds into combustants that could be burned in chemical rocket engines. While such schemes could work, they require the establishment of expensive and complex infrastructure, and moreover tie down the exploratory craft to dependence upon fixed bases. A better way is to use nuclear thermal rocket (NTR) engines, such as those developed under the NERVA program of the 1960s, to heat locally available gases or liquids directly to form a high thrust rocket exhaust. Because the energy required to simply collect and liquefy a native gas (such as martian CO_2) is generally about 1/100 the amount required to break down that gas into chemical reactants (i.e., CO and O_2), no infrastructure is required. Instead, the propellant acquisition system can travel with the vehicle, allowing it to refuel itself each time it lands. Complete and unlimited planetwide mobility is thus obtained.

In this article I am going to present a preliminary examination of the potential implementation of such a concept in the contexts of manned Mars missions and unmanned exploration of Saturn's satellite, Titan. In the case of Mars, I call the vehicle in question the NIMF, for Nuclear rocket using Indigenous Martian Fuel.

CANDIDATE MARTIAN PROPELLANTS

The atmosphere of Mars consists of 95.0% carbon dioxide, 2.7% nitrogen, and 1.6% argon, all of which are candidate fuels for a NIMF. Water could also be used after harvesting ice or permafrost. If we are willing to engage in some chemical synthesis, then carbon monoxide could be manufactured by stripping CO_2 and could either be used as a propellant directly, or reacted with water to produce methane propellant.

How good are these propellants? The performance of a rocket propellant is ordinarily gauged through its "specific impulse" (Isp), which is directly proportional to the maximum exhaust velocity it can produce (multiply the specific impulse by 9.8 m/sec^2 and you get the exhaust velocity in meters/sec). The following chart shows the ideal specific impulse obtainable with each of the above propellants at various temperatures.

In table I, 2800 K may be regarded as a safe operating temperature, as NERVA (carbide), uranium-

NUCLEAR ROCKETPLANE USING INDIGENOUS MARTIAN PROPELLANT

The vehicle shown on page 32 utilizes onboard pumps to liquify carbon dioxide out of the martian atmosphere to provide propellant for a nuclear thermal rocket engine. Since the vehicle can refuel itself each time it lands, unlimited mobility is achieved for planetary exploration.

Modest wings allow for highly controllable aerodynamic flight at Mach 4. Takeoff and landing are achieved using four VTOL nozzles positioned on the ventral side of the vehicle.

From bow to stern we have the control deck, habitation deck, compressor deck, main propellant tank, nuclear reactor, and rocket nozzle. The reactor is surrounded by a second co-axial propellant tank to provide additional shielding.

Engineering concept by Robert Zubrin. Painting by Robert Murray.

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thorium oxide, and "cermet" (tungsten based) fuel elements have been extensively and successfully tested in this range. Some of the final NERVA tests and cermet data both indicate that 3200 K may eventually be attainable. The final temperature of 3500 K can be taken as an ultimate upper limit to what a solid core nuclear rocket may be expected to achieve.

By comparison, a first rate chemical engine burning hydrogen and oxygen (like the Space Shuttle main engines) can achieve a specific impulse of about 460 seconds. Thus, with the exception of methane, the potential NIMF propellants are inferior performers to the best chemical fuels. The old NERVA program wanted to create a nuclear engine whose performance could leave chemical engines in the dust, and so it concentrated exclusively on hydrogen propellant, which yields a specific impulse of 950 seconds. That's excellent for rapid and comparatively inexpensive interplanetary (and Earth-Moon) transfer, but for operations about a planetary body, the ability of an engine to obtain its fuel locoally is far more important than its abstract performance.

Let's take a look at the characteristics of each of the candidate Martian propellants.

Carbon Dioxide

Carbon dioxide is the most readily accessible of all the candidate Martian propellants. Composing 95% of the atmosphere, it can be obtained by pumping the Martian air into a tank. At a typical Martian temperature of 233 K, carbon dioxide liquifies under a pressure of 10 bars. Under these conditions, assuming an isothermal compression process, liquid CO_2 can be manufactured for an energy cost of just 84 kW-hrs (80 kW is about 100 horsepower) per metric ton (MT). The NIMF engine produces over a thousand MW (thermal). If an electrical capacity of 1 MWe is built in as well, then the (2800 K, 40 MT) NIMF would be able to fuel itself for a flight into a high orbit in less than 14 hours! Liquid CO_2 has a density 1.16 times that of water and is eminently storable under Martian conditions.

A 40 MT CO_2 propelled NIMF vehicle with a specific impulse of 280 seconds would require a mass ratio of 3.8 to ascend to Low Mars Orbit, or 8.3 to fly directly from the Mars surface into a Hohmann Transfer (8.5 month) Orbit to Earth, both of which are attainable due to the high mass density of liquid CO_2. (The mass ratio of a rocket vehicle is the ratio of the mass of the vehicle completely fueled to that when its tanks are bone dry.) Reactor power levels of about 1100 MWth would be required to generate sufficient thrust for the ascent to orbit, while 2400 MWth would be required for the direct Trans-Earth Injection mission.

Since CO_2 is so readily acquired, using it for multiple suborbital hops is quite convenient, allowing a Mars exploration mission to visit many sites. The vehicle for such an application (which would also function as the surface to orbit ascent vehicle) could take the form of either a ballistic hopper or a supersonic (Mach 4-5) winged air-

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craft. Such an aircraft could function either as a pure rocketplane, or use airborne jet intake of CO_2 to extend its range. Because of the high speeds and power levels available from NIMF propulsion, wing sizes could be quite modest, similar to those on the Space Shuttle orbiter. Landing and takeoff would require VTOL ability, and be accomplished either in the manner of the Harrier or the X-13.

As exploratory craft, such vehicles offer a massive advantage over past concepts of chemical fueled Mars hoppers, which must derive their propellant from a base production facility. The NIMF need only carry enough propellant for one-way hops, while the chemical vehicle must carry enough fuel for a round trip. This has the effect of doubling the total delta-V (velocity change) the chemical vehicle must perform relative to the NIMF for a given mission, which in turn results in squaring the vehicle mass ratio. The bottom line is that, if the mass ratio of the vehicle is to be kept within physically realistic limits, the chemical vehicle finds itself limited to hops of about 800 miles from its base, while the NIMF can take off from the Martian surface and hop directlty to any other point on the planet. Furthermore, the chemical vehicle suffers from an additional operational complication. It must use a parachute-assisted landing to accomplish even its 800 mile range. Yet when it returns to base, it must be certain of landing precisely on target, as a safe landing two or three kilometers away from the fueling station would probably result in the permanent loss of the use of the vehicle. The NIMF suffers from no such restriction. If it lands off-course, it just refuels itself and hops again.

At high temperatures, both carbon dioxide and water become oxidizers, making it unlikely that a CO_2 or water NIMF could utilize the same carbide fuel elements developed for the NERVA hydrogen propelled nuclear engine program. Instead, oxide fuel elements would have to be used. Fuel pellets composed of a combination of uranium-thorium oxide have been made with melting points above 3300 K. If coated with another oxide to prevent fission product migration into the propellant exhaust, such pellets should be able to sustain CO_2 or water driven NIMF engines with propellant temperatures of about 3000 K. The disadvantage of such oxide fuel pellets is that they would probably not be compatible with hydrogen propellant, in which case a high Isp interplanetary transfer vehicle would have to employ a separate NERVA type engine.

Water

While involving greater uncertainty and complexity in its acquisition, the use of water propellant allows for remarkable performance. For example, a 3000 K water propelled NIMF taking off from the Martian surface for Low Earth Orbit would have a mass ratio of 5.4 and require about 2000 MWth for liftoff. If a base on Phobos is used as a point of departure, a water propelled NIMF would be able to fly to Earth, aerobrake into a loosely bound orbit, and return to Mars without refueling.

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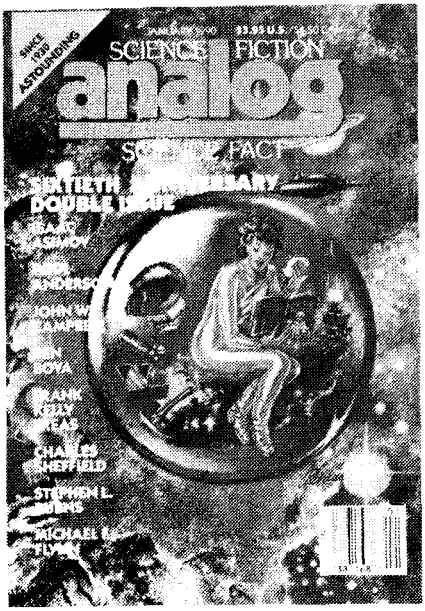

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The main problem with the use of water is finding it, and the second is harvesting it. It is believed by many planetary scientists that vast quantities of water may exist on Mars in the form of permafrost covered over by a few feet of sand. After all, the planet once had flowing rivers. The existence of such quantities of water on Mars may be verified by the unmanned probes planned by the US and the Soviets for the 1990s. At present, the only large sources of water known for certain to exist on Mars are in the north polar cap, which however is a very inconvenient place from which to launch into an orbit useful for Earth return, as the required inclination change is large. If permafrost is discovered, water will become more generally available, but it will require an operation of some complexity to harvest it. It is therefore difficult to see how an initial manned mission could be planned based on the assmption of securing water fuel for the return trip. However, once a Martian base is established, locally mined water could function as a near ideal fuel for both Earth return, near Mars, and beyond Mars (asteroidal and Jovian system) operations.

Methane

If water is acquired on Mars, then methane can be produced (along with oxygen) by using heat from the nuclear reactor to strip CO from Martian CO_2, and then reacting the CO with H_2O in the water gas shift reaction to produce hydrogen and CO_2. Some of the CO_2 is recycled to be stripped, and the remainder is then catalytically reacted with the hydrogen to produce methane and water. As can be seen from Table 1, methane is an excellent candidate propellent for a NIMF vehicle, yielding specific impulses well in excess of 600 seconds. Furthermore, since it does not contain oxygen, the use of methane eliminates one of the major problems associated with either CO_2 or H_2O, namely oxygen attack, and would be compatible with conventional NERVA carbide fuel elements. Methane, however, fully dissociates at temperatures of interest for nuclear propulsion, and the free carbons thus created may cause coking problems. This is a question that must be resolved experimentally.

Liquid methane would have to kept refrigerated on Mars, but this is not expected to present significant difficulties.

Table 1

Ideal Specific Impulse of Martian Propellants

Temperature	*CO_2*	*Water*	*Methane*	*CO or N_2*	*Argon*
2800 K	283	370	606	253	165
3000 K	310	393	625	264	172
3200 K	337	418	644	274	178
3500 K	381	458	671	289	187

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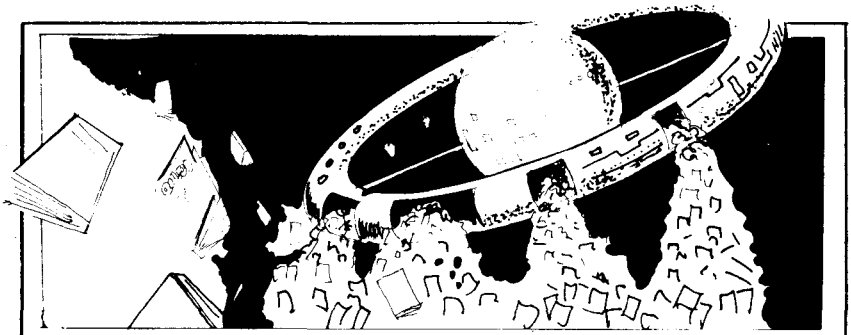

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Methane liquifies at 135 or 166 K, at 5 or 20 atmospheres pressure, respectively.

Other NIMF Propellants

Nitrogen, carbon monoxide, and argon are also potential NIMF propellants. However, as can be seen from Table 1, their performance is inferior to that of the much more accessible CO_2. Compared to the 84 kWe/MT cost of liquefying CO_2, these propellants require about 5 to 10 MWe/MT to produce. In addition, these three propellants are all moderately cryogenic, requiring storage temperatures in the 100 K range. The primary advantage of these fuels over CO_2 is their lack of chemical reactivity with fuel or cladding materials that are also compatible with hydrogen. Thus the same reactor which uses carbon monoxide for propellant for ascent to orbit could also use hydrogen propellant, taking advantage of its 950-second Isp for interplanetary orbital transfers.

Finally it should be noted that if water is available, it is possible to combine hydrogen from the water with nitrogen to form ammonia, a noncryogenic, oxygen free propellant capable of yielding an Isp of around 450 seconds at reactor temperatures of 3000 K. The processes involved may be excessively complex and energy expensive, however.

A MANNED MARS MISSION IN A SINGLE LAUNCH

Since the days of the Apollo program, NASA's thinking about manned planetary landings has been dominated by approaches based on a combination of an orbiting mothership containing long-term living quarters and a small landing craft, a fraction of which manages to ascend to orbit after a stay on the surface. The reason for such an approach has always been the fact that any mass lowered into a planet's gravity well that requires return to space will require additional fuel mass to accomplish such an ascent. Furthermore, since this fuel mass itself must be transported from Earth, which requires still more fuel, ultimately the entire mass and cost of the mission is multiplied. With the advent of the NIMF, however, such logic is no longer valid. In fact, since any mass landed upon Mars can be lifted back to orbit using readily available indigenous propellant, it becomes advantageous to abandon the concept of the orbiting mothership altogether, and instead land the entire spacecraft living quarters on the planet's surface. In other words, the NIMF and the interplanetary vessel are one and the same. All that is left in orbit is an automated vehicle consisting of either a cryogenic or nuclear thermal orbital transfer propulsion unit with associated fuel and tankage.

Let us now consider the use of the NIMF in this, its proper mission architecture, in three alternative scenarios. In each of these scenarios, a 40 metric ton NIMF carrying a three person crew is projected out of a 300 km Low Earth Orbit (LEO) onto a minimum energy trajectory towards Mars. The NIMF lands on Mars, and hops around visiting various sites, ultimately returning to Earth via a Hohmann Transfer Orbit.

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The three scenarios considered are given below:

Scenario 1: An expendable orbital transfer vehicle (OTV) propels the NIMF out of LEO onto a minimum energy transfer orbit to Mars. Upon reaching Mars, the NIMF aerobrakes and lands. The NIMF then explores Mars, hopping around to visit many sites. Finally the NIMF takes off from Mars, propelling itself directly into a minimum energy orbit to Earth. Upon reaching Earth, the NIMF aerobrakes into LEO.

Scenario 2: An OTV propels the NIMF out of LEO onto a minimum energy transfer orbit to Mars. Upon reaching Mars, the NIMF and the OTV aerobrake separately, leaving the (automated) OTV in Low Mars Orbit (LMO), while the NIMF lands. After exploring Mars, the NIMF takes off for LMO and rendezvous with the OTV. The OTV then drives itself and the NIMF out of LMO onto a minimum energy orbit towards Earth. Upon reaching Earth, the NIMF and the OTV aerobrake into LEO.

Scenario 3: An OTV drives the NIMF onto a minimum energy transfer orbit to Mars. Upon reaching Mars, the OTV rocket brakes itself 1 km/s into Mars's gravity well, while the NIMF aerobrakes and lands. After exploring Mars, the NIMF ascends to orbit and rendezvous with the OTV. The OTV then drives both onto a minimum energy orbit towards Earth. Upon arrival, the OTV rocket brakes both into LEO.

Scenario 1 would require interplanetary transfer to take place under zero-gravity conditions. In scenarios 2 and 3, various amounts of artificial gravity could be provided by linking the NIMF and the OTV with a tether, separating the two at a distance, and spinning up the assembly.

We include within our analysis three different OTV propulsion systems. The first is a cryogenic LOX/hydrogen engine with a specific impulse of 470 seconds. The second is a NERVA type nuclear thermal engine with an Isp of 950 seconds. The third is a pressure fed nuclear thermal rocket (PFNTR) such as that invented by Carl Leyse and his collaborators at the Idaho National Engineering Laboratory, which uses lower chamber pressures and higher temperatures than a conventional NERVA engine to achieve partial hydrogen dissociation and an Isp of 1300 seconds. The cryogenic propulsion OTV is assumed to consist of several stages, one for each required burn, with each stage composed of 87% fuel mass and 13% dry mass. The NERVA and PFNTR are assumed to weigh 5 metric tons each, and additionally require tankage stages filled with hydrogen fuel, with each tankage stage composed of 83% fuel mass and 17% dry mass. Aerobrake masses are taken as 0.15 of the maximum masses required to be decelerated.

Given these scenarios and upper stages, the results of our study are given in Table 2 .

In Table 2 all masses are given in metric tons. By the end of the 1990s, we expect to have available launch systems such as Shuttle-C (80 MT to LEO capacity), ALS (100 MT to LEO), and

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The Shape of Things to Come

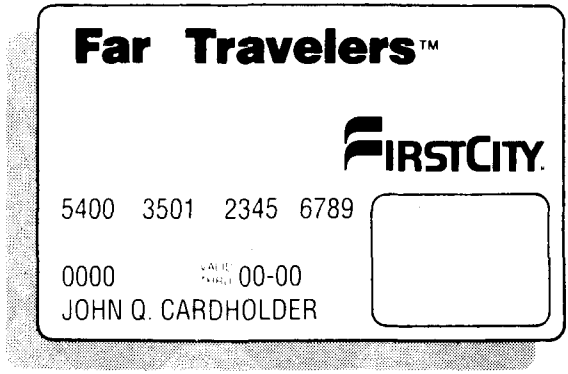

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Table 2

INITIAL MASS IN LOW EARTH ORBIT (MT)

ALTERNATIVE SCENARIOS FOR NIMF MANNED MARS MISSIONS

	Scen. 1	*Scen. 2*	*Scen. 3*
Cryo OTV			
Mission Mass	106	199	495
Expended Mass	66	154	445
NERVA			
Mission Mass	73	100	145
Expended Mass	33	53	100
PFNTR			
Mission Mass	64	80	104
Expended Mass	24	33	59
NIMF Mass Ratio			
CO_2 Propellant	8.3	3.8	5.6
H_2O Propellant	5.4	2.9	4.0
CH_4 Propellant	2.9	1.9	2.3

Shuttle-Z (a Shuttle-C with 4 main engines and a chemical second stage inside an enlarged payload fairing, 125 MT to LEO). It can be seen that there are numerous mission architectures where an initial manned Mars mission can be accomplished with a single launch of the Shuttle-Z or ALS, and even several where an initial mission can be accomplished with a single Shuttle-C flight. Furthermore, repeat missions (whose requirement is given in the "expended mass" lines in Table 2) in many scenarios can be accomplished with a single refueling flight by an STS (25 MT to LEO), a Titan IV Upgrade (35 MT to LEO), or a Shuttle-C. This is in marked contrast with current NASA Code-Z/Office of Exploration mission plans, which are based on orbiting motherships, and cryogenic propulsion for interplanetary transfer and landing vehicles. Such plans involve from 700 to well over 1000 metric tons of propellant per mission, requiring 6 or more Shuttle-Z launches per mission! Furthermore, despite their enormous cost and complexity, such mission plans leave the astronaut-explorers relatively impotent to accomplish much in the way of either exploration or development, as their cryogenic landing vehicle will necessarily restrict their visit to one site, and they lack a substantial source of electric

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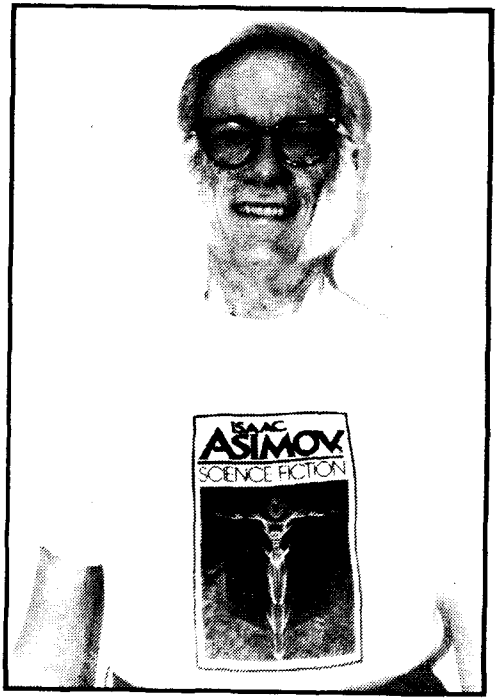

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or thermal power.

The conventional mission plans Code-Z is currently examining offer little potential for human exploration of the Red Planet, and none at all for sustaining a human presence there. By contrast, the one-launch mission architecture made possible by combining the NIMF with a hydrogen fueled nuclear thermal orbital transfer vehicle (either NERVA or, better yet, the PFNTR), will allow ready, repeated, and inexpensive access to Mars, and will open up a new world to human colonization.

MISSION TO TITAN

Titan, Saturn's largest moon, possesses an abundance of all the elements necessary to support life. Many scientists believe that its chemistry may resemble the Earth during the period of the origin of life, frozen in time by the slow rate of chemical reactions in a low temperature environment. The abundant prebiotic organic compounds comprising Titan's surface, atmosphere, and oceans may one day provide the basis for extensive human settlement. However, because of its thick cloudy atmosphere, the surface of Titan is not visible from space, and many basic facts about this world remain a mystery. Thus a mission that could bring back samples from various locations on Titan and also perform a low-level aerial reconnaissance would be of immense scientific benefit. As we shall see, the NIMF can accomplish such a mission.

Titan's atmosphere is composed of 90% nitrogen, 6% methane, and 4% argon. The atmospheric pressure is 1.5 that of Earth sea level, but because of the surface temperature of 100 K, the density is 4.5 Earth sea level. The surface gravity is ⅐ that of the Earth, and the wind conditions are believed to be light. However, a great unknown is the composition of the surface. It may be rock and water ice, it may have methane lakes and rivers, or the entire world may be covered by a methane ocean. (Latest evidence from radiotelescopes using Earth-based radar indicates the existence of a mixed terrain, including at least one solid continent in the methane ocean.) The presence of higher hydrocarbons and other organic compounds within the bodies of liquid methane is highly probable, but the precise chemical nature of the mixture is unknown. Hydrocarbon and ammonia ice may also exist. These facts help determine the strategy that the NIMF Titan Explorer (NIFTE) mission will adopt.

The NIFTE mission is initiated by lifting an 8 MT unmanned automated NIMF fueled with 10 MT of liquid hydrogen to LEO. Such a launch can be accomplished by either an STS, a Titan IV, or an upgraded Titan III. The NIMF uses the hydrogen propellant to generate a delta-V (velocity change) of 7.6 km/s, driving itself onto a 4 year trajectory to Titan. Arriving at Titan, the NIMF aerobrakes itself into the atmosphere, with a modest entry velocity of 6.2 km/s. Of the 8 MT arriving at Titan, 2 MT are scientific payload, 3 MT comprise a 300 MW nuclear engine and its shield, and 3 MT are devoted to structure and machinery.

Because surface conditions are un-

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known, the NIMF will not land. Rather it will use atmospheric intake of propellant and aerodynamic lift to remain airborne. Such a mission strategy is uniquely appropriate to Titan as, with its thick atmosphere and light gravity, this world is the aviation paradise of the solar system. In fact, a human being standing on the surface of Titan would be able to fly by strapping wings onto his or her arms in the manner of Daedalus and Icarus (and this will no doubt be the preferred mode of transportation among the human settlers of Titan). More to the present point, an 8 MT NIMF moving at 100 mph would require a wing area of only 4 square meters to remain aloft (i.e., no wings at all)! Since fold-out wings of about 100 square meters can be easily accommodated within the payload fairing of the Titan IV, the NIMF Titan Explorer will be able to cruise as slowly as 20 mph, performing a leisurely low-level aerial reconnaissance of the entire satellite.

As it cruises along, the NIMF Titan Explorer will deploy small electric (battery or RTG) powered aircraft to collect samples from the atmosphere, surface, and submarine regions. These electric aircraft, which I call TERNs (for Titan Explorers and Retrievers to NIMF) would mass about 10 kg each and could take the form of helicopters, fixed-wing tilt rotor seaplanes, dirigibles, or even diving submarines, capable of both aerial flight and subsurface travel in the methane ocean (the low gravity, thick atmosphere, and low density of liquid methane all contribute to making such a vehicle possible). As the NIMF Titan Explorer carries a scientific payload of 2 MT, a large variety of TERNs could be carried, anticipating a variety of surface and subsurface conditions, so as to ensure the success of at least several of these probes.

After Titan has been adequately explored and samples collected, the NIMF Titan Explorer will then address itself to investigating the remaining satellites in Saturn's system. Flying in Titan's atmosphere, the vehicle can acquire and liquify methane, which, as we have already noted, is an excellent nuclear thermal rocket propellant, yielding a specific impulse between 560 and 670 seconds. By filling its tank with methane (and assuming a modest Isp of 560 s), the NIMF Titan Explorer can provide itself with a delta-V of 12 km/s. This is sufficient not only for a high energy return to Earth, but also for serial excursions for multiple sample collections from Saturn's other satellites.

In Table 3 we see the delta-V's required for excursions from Titan to Saturn's other moons. Each excursion involves landing on the destination moon twice, collecting samples from two locations separated by up to 40 degrees of latitude or longitude, and then returning to aerobrake and refuel at Titan.

THE HUMAN SETTLEMENT OF TITAN

In many ways, Titan is the most hospitable extraterrestrial world within our solar system for human colonization. In the almost Earth normal atmospheric pressure of Titan, you would not need a pressure suit, just a dry suit to keep

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Table 3

NIFTE VISITS TO SATURN'S OTHER SATELLITES

Destination	Distance from Saturn	Radius	Delta-V
Mimas	185,600 km	195 km	13.17 km/s
Enceladus	238,100	255	11.25
Tethys	294,700	525	10.05
Dione	377,500	560	8.60
Rhea	527,200	765	6.91
Titan	1,221,600	2575	0.00
Hyperion	1,483,000	143	3.84
Iapetus	3,560,100	720	6.90
Phoebe	12,950,000	100	8.33

It can be seen that with its delta-V capability of 12 km/s, the NIMF Titan Explorer can collect multiple samples from all of Saturn's moons, except Mimas, and bring them back to Earth.

out the cold. On your back you could carry a tank of liquid oxygen, which would need no refrigeration in Titan's environment, would weigh almost nothing, and which could supply your breathing needs for a week long trip outside of the settlement. A small bleed valve off the tank would allow a trickle of oxygen to burn against the methane atmosphere, heating your breathing air and suit to desirable temperatures. Strap-on wings would provide an easy and pleasant form of personal locomotion. Electricity could be produced in great abundance, as the 100 K heat sink available in Titan's atmosphere would allow for easy conversion of thermal energy from nuclear reactors to electricity at efficiencies of better than 80%. Most importantly, Titan contains billions of tons of easily accessible carbon, hydrogen, nitrogen, and oxygen. By utilizing these elements together with heat from nuclear reactors and seeds and a few breeding pairs of livestock from Earth, a huge agricultural base could be created within a protected (but rapidly growing) biosphere on Titan.

The main difficulty to realizing this goal is transportation. I call current space transportation systems First Generation. These are sufficient for launch into Earth orbit, for a few manned visits to the Moon, and for limited capability unmanned probes to other planets. For colonization of the Moon and Mars, we need to move on to Second Generation systems, typified by nuclear thermal rocket propulsion, aerobraking technology, and the NIMF. Such Second Generation systems also open up capabilities for vastly expanded unmanned explo-

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ration of the outer solar system, exemplified by the NIMF Titan Explorer mission described above. They are, however, marginal for manned colonization of Titan, as the three to four year one-way flight times they require for this mission are excessive. However, the information flooding back to Earth from the NIFTE mission is sure to arouse the curiosity and sense of adventure of some, and by improving the in-space life support systems of the Second Generation (and by moving from the Second Generation's simple air and water recycle in the direction of closed cycle ecology as the basis for very long term life support) a few pioneers will make their way to Titan using Second Generation transportation technologies. Once even a very small base is established on Titan, there will be a tremendous incentive to develop Third Generation systems, such as fusion propulsion, which will allow for quick trips and rapid settlement of Titan and the rest of the outer Solar System. Such Third Generation propulsion systems, however, together with fully Third Generation closed cycle ecological life support, create at least a limited basis for interstellar missions, with flight times to nearby stars on the order of 50 years. And just as Columbus's discovery of the New World called into being the full rigged sailing ships, steamers, and Boeing 707s that allowed the rest of humanity to follow in his wake, so those brave souls who dare the great void between stars with ships of the Third Generation will draw after them from the well of limitless creativity inhabiting Earth-Luna-Mars-Titan a set of Fourth Generation space transportation systems, whose nature I would not presume to predict, but whose capabilities will open up the galaxy for humankind.

The key transitional step towards this vision of the future needs to be taken today. The development of nuclear rocketry using indigenous propellants will give us Mars, and at least a handhold on Titan. And when we pull ourselves up on that handhold and look beyond, we shall see the stars, and they shall be no longer beyond our reach. ■

About the Author

Robert Zubrin is a senior engineer at Martin Marietta Astronautics, working on advanced space transportation systems

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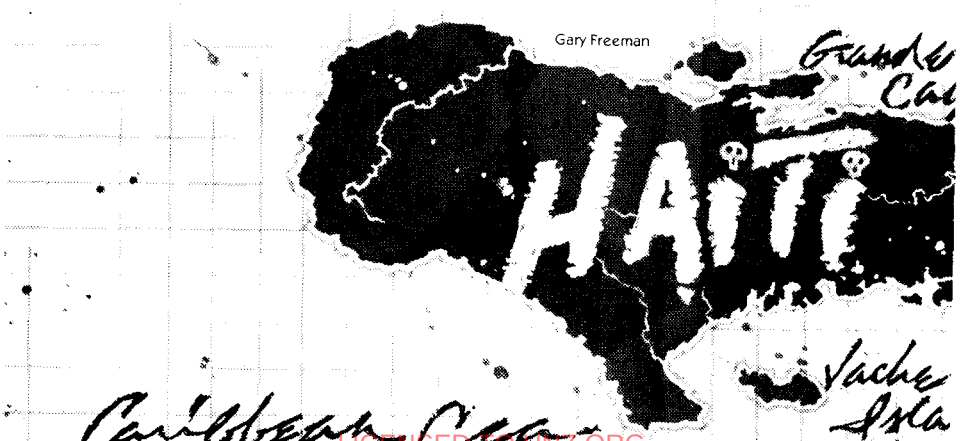
Practically everyone thinks of ecology and medicine as quite separate and distinct—which just may be a fundamental flaw in everyone's thinking.

THE SOLOMON SOLUTION

Paula May



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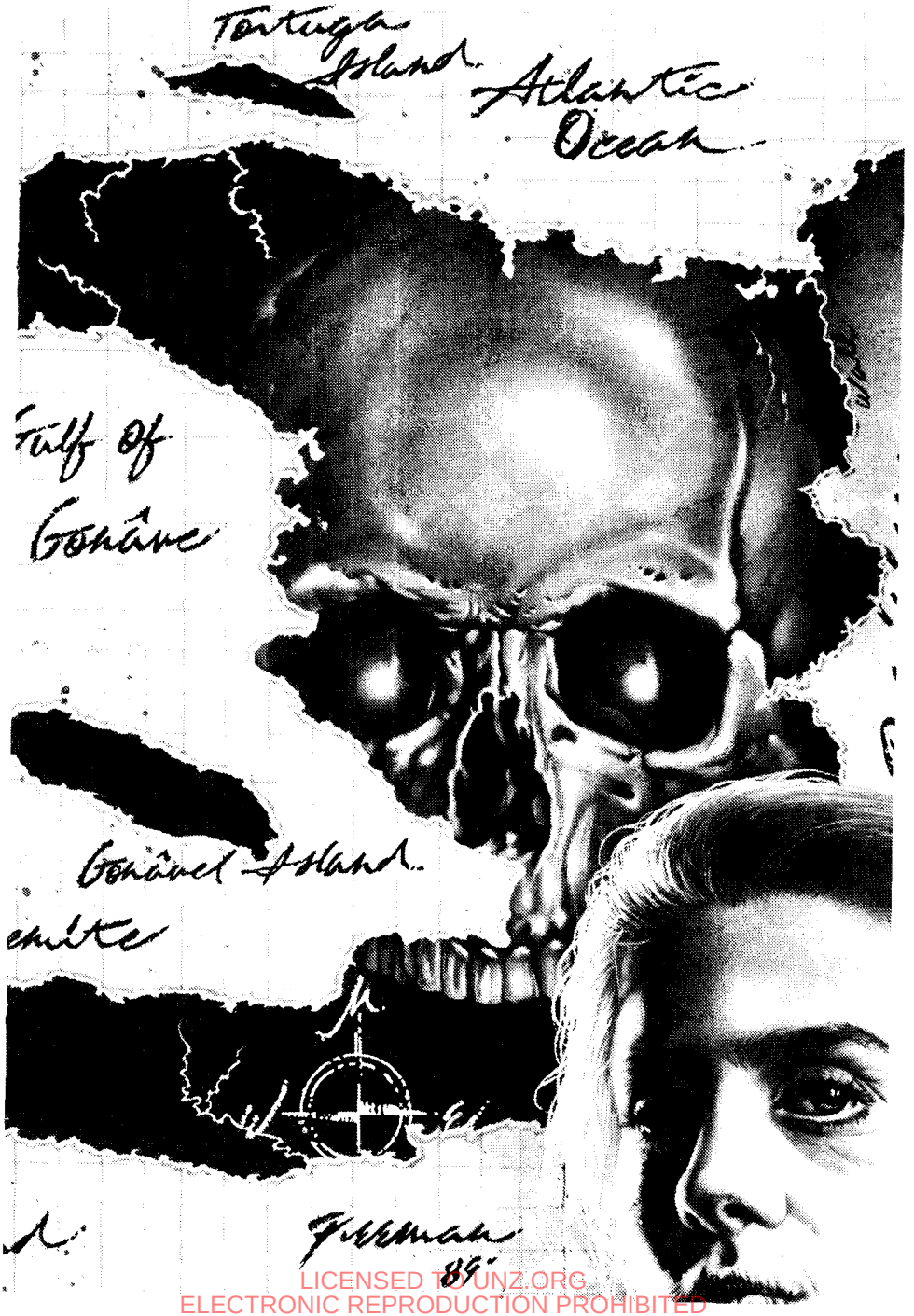

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I. Ring a ring o' rosies

September, 1665. Eyam, Derbyshire, England. Population—350 to 400. Main industry—lead mining. Located on the south face of Eyam Edge, Eyam is a pretty Low Peak village, unremarkable but for two things. Little Eyam has two pastors, the old Puritan one and the Restoration one who displaced him, and little Eyam has a problem. The problem is not doctrinal dispute, as you might expect, but Plague. The Plague has somehow come to Eyam, perhaps with a parcel from London, perhaps not. However it came, Plague works its uneven way through the village, killing, pausing, then killing some more. The pastors disagree about the cause of the disease as they disagree about most things, yet for their different reasons both urge the village to shut itself off from the rest of the world in late spring, 1666. Believing that they must contain the contagion to spare their neighbors or believing that they must bow their wills to the test which God has set them, perhaps believing both, the 350 Eyamites who remain, swear an oath to sequester themselves until the Plague has spent itself. With the help of the Duke of Devonshire, who supplies all necessary victuals at his own expense, the village is sealed off. Then the horror begins in earnest.

"We have *power*, brothers and sisters, such as *nobody* has had before. We can save the *world*, brothers and sisters, save the *whole world*, but only if we do it *toGETHER*. Our *power* lies in total UNITY, beloved brethern. Let us come *toGETHER* in holy harmony. . . ."

Solomon Jackson. Haitian by birth, Canadian by naturalization, fanatic by inclination, AIDS carrier by misfortune. Irene Gauss had ignored his bizarre Vision and the aberrant movement it spawned. Common sense told her the whole thing would trip over its own patent absurdity and fall apart. Taking on a hospital full of terminally ill infants, instead of retiring, had left her neither time nor energy for brother Solomon, anyway.

Now, staring at her distorted reflection in the mirror lenses the National Guard officer used so effectively to separate his humanity from the world, Dr. Gauss knew that she should have made time, that she'd overestimated the power of common sense. Common sense is the first thing to go when people are scared. People were scared now, deeply scared, scared enough that they'd sent this pseudosoldier and his pseudotroops to take her babies. She'd never wanted the babies, never asked for the burden of the hospital, yet when the government had thrust the burden at her she'd found herself incapable of refusing it. Just as she now found herself incapable of letting the burden go.

She folded her hands tightly on top of her paper shrouded desk to hide her trembling. "Absolutely not, Major. You are neither equipped nor trained to transport infants. This is my hospital and these children are my legal responsibility. Now please leave quietly or I'll be forced to call in the law."

"Afraid I *am* the law, Dr. Gauss. These orders," he waved a paper, "are presidential and as you know, presidential directives take precedence over any

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and all other legal instruments in the handling of AIDS-infected persons."

"These aren't just any AIDS-infected persons, Major, they're babies. They're orphans, born to AIDS-infected parents who have died or are too ill to care for them. Nobody will adopt or foster them, so they end up here. At first there was a ward of them, then a floor, then a wing, finally a whole hospital. A whole hospital, Major. Do you really understand how many babies you have here?"

"You'd better read these orders, Doctor." He handed her the paper, continuing as she read. "The government has modified three 747s with cribs and incubators to make them flying nurseries. They've taken several flights of infected babies from West Coast and Southern cities already, with no problems. President Jackson has set up crèches and supplied trained nurses to man the flights."

"*President* Jackson? Now, who might that be?"

To his credit, the major looked momentarily uncomfortable. "Solomon Jackson's calling himself the president of Haiti now, Doctor. He does seem to have things under control at his end, and since the Haitian government fled five months ago, I don't see that the title hurts."

"Major, I don't really care whether Solomon Jackson calls himself the president of Haiti or the king of hell. Do you know why this stuff has to be done under presidential authority? Because it's illegal, that's why. It's all totally illegal, has been from the start, so the only way to do it is to grossly abuse executive power. It's not only illegal, it's damnably immoral."

"Dr. Gauss, nobody made all those people go with Solomon Jackson. They volunteered to go."

"My babies haven't volunteered, Major, and there are more conscripts than volunteers in the Enclave now. The people of Haiti didn't volunteer to have 40,000 AIDS carriers descend upon them each month. The Haitian government didn't volunteer to fall. What Jackson proposed was insane, what he did was inexcusable, and for governments to support him and his AIDS Enclave is unforgivable."

"I'm sorry you feel that way, Doctor." A revolver leapt into his hand. "I'd rather not shoot you, ma'am, but I will if I have to. Now, get up very slowly and walk slowly around the desk. Keep your hands where I can see them."

Gauss did as she was bid. The major marched her out of her office, down the hall to a storage closet. He shoved her in and closed the door. He didn't bother to turn on the light.

After a couple of minutes, Gauss tried the door. It was locked. It was a fire door, steel, tightly sealed, so she knew there was no point in pounding on it or calling for help. She sat down with her back against the door, clutching the Major's orders under her chin in the dark, imagining she could hear feeble cries from the purloined babies. Somebody should have had the common decency to do something before it came to this. Somebody should have. Somebody. Something. Something different.

II. A pocket full o' posies

Summer, 1666. Eyam, Derbyshire, England. Population—dwindling fast.

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Main industry—dying. Eyam still has two pastors, but is no longer unremarkable. So well remarked has Eyam become that when a few of her folk lose their resolve and try to creep away, they are driven back by the watchmen who have been set upon the roads by the neighboring towns to enforce Eyam's "voluntary" isolation. Summer is one long dog-day of death for Eyam. The Plague stalks her street in two guises: Bubonic plague, the slower, fever-driven form with its hideous, grotesque swellings called buboes on neck, in armpit or groin, and the Pneumonic plague, the faster form, starting and spreading with a cough. Disease ravages family after family, killing all in one home, leaving a lone survivor to weep in the next. The well ones drink gallons of sage tea, burn purifying bonfires, take physicks sent up from London and still fall ill. Eyam fills her churchyard with her dead and her folk turn to home burial. Sometimes the last member of a family to die lies for days in the summer heat before the smell is noticed, and the grave digger sent for.

"Dr. Gauss, if you're to catch that UN plane, you'll have to get ready now."

Irene Gauss looked up into the blurry face hovering over her. What UN plane? Her eyes snapped into focus. The UN plane to the supply/staging area in the Dominican Republic. She pushed aside the data sheets.

"Right you are. Lost track of time. Monkeys picked a hell of a time to get sick, didn't they?" Gauss smiled up at her Ghanaian lab assistant.

"Always. Don't worry. We'll find out what it is." The assistant was overtaken by a coughing fit.

"Too much monkey dander," suggested Gauss.

"Or too many cigarettes. One thing for certain is that it isn't one of the primate SIVs. It has simply spread too fast, moved along too smartly for that. Probably some local monkey fever. With a bit of luck, we'll have it all sorted out by the time you get back. If we can't cure these, we'll buy more from the breeder and prep them. We'll be ready for the disease trial when you return."

"I hope so. Nothing more annoying than having your disease trial disrupted by a volunteer disease. See you in three days."

Gauss packed quickly and just made the UN plane. She dozed fitfully during the Atlantic crossing from Ghana, awakening at a bump of turbulence as the plane descended to the military airport. Looking out, she caught a glimpse of the Wall before airport buildings cut off the view.

After a perfuntory immigration check, the doctor made her way to the odd UN-sponsored PX cum bar at the edge of the field. She ordered something tall, cold, and fruity from the bar. It didn't really taste like much, but the cold felt so good on her travel-parched throat that she ordered a couple more before a UN aide found her. He took her carryall over her objections, helped her from her seat, took her elbow firmly and steered her through the door of the PX, across the tarmac to the UN supply plane. When the aide started to climb the steps into the plane with her, Gauss lost her temper.

"I'm not feeble, young man."

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"Beg your pardon, Doctor?"

"I can manage the steps on my own, thank you."

"Sorry, Dr. Gauss." He handed her the carryall. "I thought you looked tired."

"I was up all night with sick monkeys. I'm tired, all right. Possibly even a bit snappish, for which *I* am sorry."

He smiled. "I'll meet your plane after the drop."

"Good. Thank you." She climbed the steps. The carryall bumped against the handrail at every step.

Gauss strapped herself into one of the seats behind the pilot. The pilot didn't acknowledge her presence, though the copilot took a second from his instrument check to nod in her direction. Gauss looked out the window as the plane began to move and felt instantly giddy. She closed her eyes and frowned. She'd thought the drinks she was ordering were nonalcoholic. No wonder the aide had been so attentive. Well, maybe the buzz would insulate her a little from what she was about to see. The plane leveled off and she opened her eyes just in time to get a good look at the Wall.

A thousand-meter gash had been chemically carved through the lush green of the Dominican countryside, that no creeping vegetation should obscure the view from the observation platforms atop the barrier that crouched in the middle of no man's land. Fifteen sheer meters high, twenty meters wide, solid, the Wall stretched from shore to shore, separating the Dominican Republic from what had been Haiti, what was now the AIDS Enclave. As the plane turned its back to the rising sun, passing over the Wall, Gauss could see the machine gun emplacements all along the walltop, ensuring that Solomon's volunteers stayed volunteered. Then the Wall was gone and they were over the Enclave.

There were trees and indistinct fields. A few villages flashed by, no lights showing despite the dark. The sky lightened. The villages turned out to be more like remains of villages, many burned structures, collapsed roofs, abandoned vehicles, vegetation tall in the streets. Nearer Solomon's capital there were signs of occupation, still no lights, but thin wisps of smoke that suggested cook fires. They passed over a massive graveyard, kilometer after kilometer of unmarked mounds, with hundreds of bodies, presumably corpses, lying unburied at one end.

The plane began to circle over a small airport. Gauss felt rumblings from the cargo hold behind her and saw parachutes blossom beneath the plane, crates of supplies dangling below them. The crates landed but no one came out of the buildings which ringed the overgrown runways. The plane swung lower. There were remains of supply crates all over the field, some with cargo lying scattered around them. Several crates from previous drops sat untouched on the cracked tarmac.

"Have to recommend they reduce the drops again," commented the copilot.

"Again?" Gauss asked.

"Yes, ma'am," said the copilot. "We've reduced supplies on a fairly regular basis over the last eighteen months. They seem to be, uh, having some, uh, some decrease in population down there."

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"See if his majesty is on the air this morning," ordered the pilot.

He banked the plane toward central Port-au-Prince while the copilot twiddled dials on the control panel. A burst of static crackled from the overhead speakers, then the faint but unmistakable voice of Solomon Jackson.

"There he is, making the morning wake-up call. Who the devil does he think is listening?" The pilot sounded angry.

Standing out from the darkened cityscape ahead was the Presidential Palace of Haiti, brightly illuminated by electric lights, probably the only ones working in the Enclave. Jackson must broadcast from there. The Palace looked in good shape, at least from a distance.

"You're listening," Gauss remarked drily.

The copilot reached forward and turned off the radio. The pilot began to turn the plane in a lazy swing over a fire-blackened section of the city. Gauss glimpsed several bodies lying in the ruined streets and, having seen enough, focussed her eyes on the horizon. As the plane's nose swung into the dawn, Gauss caught a sparkle of sunlight reflected by the mast of one of the ships in the naval blockade that ringed the Enclave.

The Navy's probably listening too, she thought, and Solomon Jackson, alive still against the odds, as egomaniacal as ever, knows he has an audience. She tried not to think of her babies. She doubted they had survived long down there. She hoped not. If they had, they'd be children now, not babies. To grow into a child in King Solomon's Hadean realm would be horrific beyond bearing. The hospital had been so quiet when the nurses had let her out of the storage closet, the empty little beds a silent accusation.

Gauss awoke with a start as the plane touched down at the staging field. Her head was splitting. She dragged herself out of her seat, thanked the pilot and copilot, staggered a little on her way to the door, made it down the steps without falling. The UN aide, waiting as promised at the base of the steps, offered her his arm and she took it gratefully.

The aide took her back to the PX/bar. Mindful of her head, Gauss ordered lemonade and got funny-tasting 7-Up. She was halfway through the drink when a jeep pulled up in front of the PX and an American Army sergeant came in looking for her. The jeep whisked her to a military transport. Gauss was just about in her seat when the plane began to taxi.

Gauss leaned her forehead against the cool glass of the window and dozed off. She woke up sometime later, coughing heavily. She straightened in her seat, her neck stiff from leaning, every cough making her head throb. The coughing went on and on, dry and hurtful.

"Sounds like you need one of these." A uniformed man was leaning over the empty seat beside her, offering her a roll of cough drops.

"Thank you," Gauss gasped between coughs, taking one of the wrapped squares.

"Take a couple more," the soldier suggested. "This pressurized cabin air really dries you out."

The cough drop mixed with her saliva, searing her throat with icy fire. It felt wonderful. She cleared her throat.

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"Thank you. You're very kind." She helped herself to two more drops.

"I always carry a couple rolls when I fly." He glanced down at her rumpled clothes. "Civilian, eh?"

"UN. World Health Organization."

"Ah. AIDS task force?"

"Yes. The Ghana research station."

"Ghana. You must be really jet-lagged about now. You can still catch another hour or so of shut-eye before we come in to Washington." He straightened up and headed off down the aisle.

"I will. Thanks again."

He waved as he disappeared between the seats.

Gauss dozed again, awakening as the plane touched down in Washington. She took another of the soldier's cough drops to ease her throat and filed out of the plane with the other passengers, her carryall pulling painfully on her sore neck.

A big black car was waiting for her on the runway. Two suited men in sunglasses loaded her into the back, got in the front and drove her away. They didn't bother with immigration. She leaned her head back and dozed as the car made its way through the traffic. She awoke to her name.

"Dr. Gauss? Sorry to wake you, ma'am." The man who was riding shotgun was turned to look at her. She saw he had an earplug in his left ear. The car was passing through tall gates.

"We're to take you straight in. He's just come out of a meeting and will see you right away."

Gauss nodded, unwrapping the last cough drop. In yesterday's clothes, smelling of mentholyptus and heaven knows what else, she was going straight in to see the president of the United States. Great.

They hustled her through empty corridors, smoothly relieved her of her carryall and purse, apologetically searched her and ushered her through a heavy door. The president came toward her, hand outstretched, smiling, apparently oblivious to her disheveled state.

"Dr. Gauss, how well you look. So good of you to come straight from the airport like this. Sorry for the rush but we've got a little problem in the Med today. Now, what can I do for W.H.O.?"

Gauss felt thick-headed. She couldn't remember what she was there for. "I'm sorry. I'm sorry. I just came from the Enclave."

The smile shrank and hardened. "Have you? I wasn't aware of that."

"Are you aware of what it's like there? Have you been there?"

The smile vanished altogether. "I haven't been there, no, but I have had a good deal of intelligence. I am aware of the situation."

"The living conditions are appalling. It's inhuman to leave them there like that. It's unAmerican for your administration to support this policy."

"Well, now, we don't exactly support the policy. You must believe me when I say that we had no idea what Solomon Jackson was up to until he made his announcement. He had been preaching voluntary isolation for a couple years before then, of course, but we had no idea that he had set up an enclave in Haiti and had been quietly sending people there. It was set up as a resort. The Haitian government itself didn't suspect, even when people began to

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overflow into the country villages. Nearly twenty thousand AIDS carriers were already in the Enclave when Jackson made his public announcement. Then they started pouring in from all over, the Haitian government fell within two months and Jackson took over. We have merely assisted AIDS carriers to reach the Enclave."

"Like you assisted my AIDS babies? Like you've assisted all the people who've tested positive in the mandatory blood tests?"

The smile came back. "You must be tired, Dr. Gauss. Why don't we sit down to talk?" He guided her to a visitor's chair before his desk, then went around to sit in his own heavy, leather chair. An American flag stood just behind him. He leaned forward, elbows on the desk.

"Dr. Gauss, I am a political creation. I represent the American people. The American people support the isolation of the Enclave. Furthermore, the policy seems to be working. The blood testing has not turned up a single new case of AIDS in this country for nine months. Not one. The Western Allied Nations have had no new cases for a year. Ghana has turned up only two new cases this year, both of whom requested immediate transport to the Enclave. I cannot, in all conscience, consider changing a policy which enjoys wide public support and is so clearly working for the public good. Now, if this is what you came to talk to me about. . . ."

"No, no it isn't what I came for." She was too tired to worry about interrupting him. The Enclave *wasn't* what she'd come for. She knew the Enclave was a lost cause. Research was why she'd come.

"No, I came because I heard you were considering another cut in AIDS research funding. I came to urge you to reconsider the cut. It's unlikely that quarantine will work with AIDS. It hardly worked with bubonic plague, which develops relatively quickly. AIDS is much longer term, lies hidden for so long, is just so different. . . ." She could see the hardness coming into the president's face again. She hurried on. "But even if the quarantine should work in this case and AIDS is eliminated, we still need to understand it.

"Modern medicine has opened huge niches in the ecology of disease by eradicating old enemies like smallpox, typhoid, polio, diphtheria, the childhood diseases, even the plague. Germs evolve like every other part of the ecosystem and something will come along to fill those niches. AIDS is an indicator of the sort of mutation we can expect to see more of. We have come to understand it to be ready when the next wave hits.

"We're trying a new tack at W.H.O. Instead of aiming at eradicating AIDS, thus opening a niche for something worse to come along, we're trying to leave the disease in place, keep the niche filled, but reduce its severity. My team's been trying to weaken the virus with a subvirus that targets diseased primate cells. We were about to start trials of the subvirus when our monkeys picked up some extraneous infection. The second W.H.O. team is working on the long-term goal of bolstering the human immune system. Not just immunizing against this disease or that

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disease, but strengthening the body's response to all disease. We need more money, not less, and research exemption from the AIDS laws.

"Given the current laws, not only are we unable to do research with AIDS sufferers, but we aren't even allowed to keep live virus to work with. I have to live in Ghana and study primate SIV because that's as close as I can get to human AIDS. It's not good enough, Mr. President, it really isn't." There was more she should say, much more, but she was tired, tired of planes and smiles and waging losing battles.

"You've made several telling points there, Dr. Gauss. I understand your concern. I really do. Rest assured that I do appreciate what you're saying." He rose and walked around the desk. He held out his hand and helped her to her feet. "Unfortunately, there really isn't much public support for AIDS research just now, but I will do what is possible within the bounds of my office. My power is much more limited than people imagine, you know. I'm not the Lawmaker or the Judge, Dr. Gauss, I'm just the Sheriff."

Gauss missed a step. He was echoing the 'Get Out of Dodge' line, the getting-tough-with-AIDS stance that had won him the last election, not just echoing it but throwing it in her face. It was all suddenly too much. Her knees gave way, sprawling her in an inglorious heap on the president's floor.

The president bent over her. "Dr. Gauss, are you all right?"

"I have to get back. My monkeys are sick. My babies . . . " Coughing seized her. "I'm sorry," she gasped at the president as two secret servicemen picked her up. "So sorry."

III. Atchoo, atchoo

November, 1666. Eyam, Derbyshire, England. Population—fewer than 100. Main industry—burning things: clothes, bedding, plague huts. The church bells have rung, proclaiming the Plague at an end, there having been no deaths since early October. Two hundred sixty-seven Plague deaths are registered in the parish records. Eyam still has two pastors and a place in history. Her neighbors were largely spared. Her people learn later that the Plague had, in fact, come to Derby, but not, by God, from Eyam.

Irene Gauss struggled for breath. She was so tired, but rest eluded her. She still had important things to impart. She opened her eyes and saw a pale face on the other side of the isolation bubble, so distorted by the plastic that it looked more animal than human. She dragged the vital words out.

"I tried to tell them, but I was too late. I underestimated again. First common sense, then common decency, then the virus itself. I was worrying about a *new* disease coming along. The model was there, in the Black Death, but I didn't see it. I should have expected it to happen in Ghana, among the monkeys, where human AIDS may have evolved." She reached for the person on the other side of the plastic. "Solomon. It doesn't help to cut the baby in two, you see, because the virus splits, too, finds another vector for contagion and kills both halves. The real Solomon solution is to change the rules of the

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game. Tell them to run the trial. Give the sick monkeys the subvirus. Or if the monkeys are all dead, give it to me. Nothing to lose." Fluid clogged her airway, choking off her words.

The face moved away. Irene coughed weakly. The distorted face made her think of the president's face as he'd leaned over her in his office and a perverse thought came into her head. She welcomed it. She hoped it was so. It was likely. She hoped she was the one who'd given pneumonic AIDS to the president of the United States, pay him back for the babies. She was sorry though, about the soldier with the cough drops and the UN aide and the pilot and . . .

"Sorry," she whispered as she drifted off.

Epilogue. We all fall down???

A different fictional treatment of the Plague at Eyam may be found in Jill Paton Walsh's young adult novel A Parcel of Patterns, *located for me by the clever librarians of Sandusky, Ohio from the scantiest of data. —the author* ■

IN TIMES TO COME

● Our April cover story is Michael F. Flynn's "The Common Goal of Nature," which might be viewed as being about two kinds of aliens. One of them is actually a human being, and quite successful at what he does—though some of his ideas are not exactly what humans usually expect of each other. He has the world's problems figured out, you see, and being a man used to *acting* on his ideas, he finds a way to implement his solution. It's quite simple, actually, and logically hard to refute. But he needs a little outside help, and doesn't realize quite soon enough that the folks he gets it from are some of the most *alien* aliens any of us have ever imagined. All because of one simple little difference in the way they experience the universe. . . .

We'll also have a novelette by Jayge Carr wherein a sociologist confronts the latest manifestation of the ever-popular generation gap—a teenage fad involving a new kind of "high" that is literal as well as figurative. Plus one by F. Alexander Brejcha that, among other things, looks at the cryonics concept from a disturbing new angle: why should posterity *want* to revive earlier generations' "frozen sleepers"?

A variety of other stories round out the issue, along with Margaret L. Silbar's factual look at "Scientific Diversions": turns serious researchers have taken that turned out not to go anywhere. At least one of them may seem very familiar, though in very recent cases the returns may not yet be all in.

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futures

Matthew J. Costello

There is a prejudice among certain sectors of the SF community, a healthy disdain for gaming. Now don't get all defensive. We know it's there, just as there are fans who find SF movies or comic books so much garbage, unfit to be considered in the same pages as any serious speculative fiction.

There are even conventions which tout the fact that there will be "no gaming," as if that will surely keep the riff-raff and rabble out. And looking at some of the pasty-faced gamers who crowd cons, staying up to all hours playing Star Beserker, well, you can understand some of the more reserved fans' contumely.

But I've also become aware of a healthy interest in gaming in the SF community, and not only on the part of readers. Recently George Alec Effinger wrote me saying how much he enjoyed computer games.

George's own work is in the process of being turned into a computer game. The game, *Circuit's Edge*, is due from Infocom (125 Cambridge Park Drive, Cambridge, MA 02140), the company famous for the Zork series of text adventures. I've never been a fan of text-only adventures, but recently Infocom started a line of state-of-the-art graphic adventures that, from their first release—*Battletech*—looks very promising.

Circuit's Edge is set in the world of George's *When Gravity Fails* and *A Fire in the Sun*. The books deal with George's creation, the Budayeen, an Arabian ghetto on a future earth. There are moddies to change your personality and daddies to simply alter one's mood. And the two books feature Marid Audran, a street-hustler turned unlikely policeman.

The game is well along in development. So, George sent me a copy of the two disks showing how things stood so far. The game will be, he says, "a gritty, fairly authentic visit to the world I invented in *Gravity* and *Fire*." George then went on to tell me that in the disks you can wander around the Budayeen, and meet some characters, but you can't start unraveling the mystery that's at the heart of the game.

Oh yes, you could stop by Chriga's, a somewhat sleazy club, and pick up a hooker. The game will be genuinely adult, George says, and "Tipper Gore should get a kick out of it."

(OK . . . er, yes I *did* go to the club. Just playtesting, mind you. And I did make an arrangement to meet this young lady back at the hotel. Great graphics, by the way. Very life-like.)

The game played smoothly and easily, the graphics were excellent and, with a murder mystery at its core, *Circuit's Edge* should be a wonderful game.

I've long admired the Lucasfilm people for both their games, and their attitude. They think about games—even goofy ones—in a serious way, trying to

(Continued on page 149)

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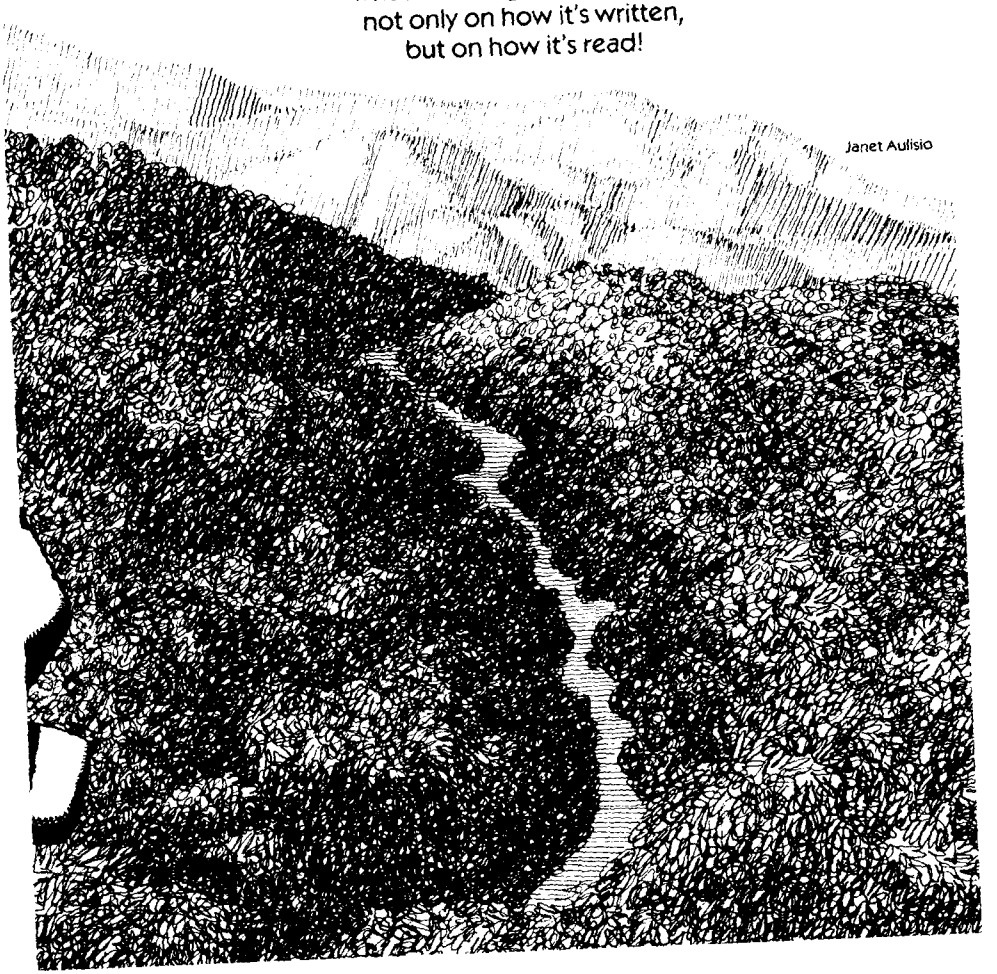
EXPRESSION OF THE PAST

Deborah D. Ross

What a message says depends not only on how it's written, but on how it's read!



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"We've taken the usual security precautions. Laser wires around the perimeter. Pressure trap in the jungle beyond the clearing. More laser wires between the buildings. Everything's tight as an airlock."

Margaret scanned over the modularized living units and laboratories set within a clearing in the forest of Arcadia. To the human inhabitants of the planet, locked in an agricultural economy, the apparent lack of barriers meant complete, blind trust on the part of the Planetary Integration Authority. But PIA wasn't that naive.

Margaret turned from her survey of the compound and faced the Security Officer. He stood ramrod straight, as if at military attention, which added even more to his height. Margaret, who considered herself a tall woman, had to bend her neck back to make eye contact. "And everything was in order prior to the accident?"

"In perfect order." Bushy eyebrows set in a perpetual frown gave Garcia a quizzical expression at odds with the certainty in his voice. Margaret found it vaguely disturbing. She didn't know whether to believe his words or his expression. "Circumstantial evidence implicates them." He turned toward the maintenance shed, where a group of native Arcadians, tools in hands, peered under the hood of a shuttle. One of the Arcadians was leaning over to make an adjustment while a PIA technician supervised. "The shuttle was serviced by an Arcadian crew just before the accident. It could have been done then."

"Wasn't their work checked by one of us?" Margaret looked up at him.

He averted his eyes and shrugged his shoulders sheepishly. "We trusted them. They were so eager to learn and picked up the mechanical stuff so quickly. Arthur was impressed. Usually a colony that has reverted to such a low tech level has difficulty comprehending high tech. Not the Arcadians. They absorbed anything we threw at them."

"What about now? You're still letting them service the flyers?"

"Yes, ma'am. We don't have any proof. We're not even sure exactly how it happened. Much of the control module was damaged beyond recognition. We don't want to accuse the Arcadians unjustly. We're keeping a closer eye on them, but not enough to indicate that we suspect any of them."

"Good idea," Margaret nodded. Fortunately, the colony wasn't overreacting to the tragedy. It was important on this, her first managerial assignment, to solve the mystery quickly and get the survey back on track. Then a twinge of fear shook her. If the Planetary Manager was the target, she was the next in line. More was at stake than just her job. "But if they did do it, why? Arthur represented PIA authority here. What did they have against him? How did they know that he would take out a shuttle?"

"We don't know how they knew, or even whether they knew. It might have been an undirected act of hostility that just happened to hit the manager. We haven't been able to come up with a motive. Everything seemed to be going so well." His voice trailed off and he ended by shrugging his shoulders.

Margaret frowned. His gesture implied a helplessness and lack of confi-

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dence that a security officer shouldn't demonstrate.

She continued to probe. "Was Arthur in the habit of taking rides alone in the shuttle?"

The man nodded. "Yes, quite frequently. Almost every afternoon in fact."

"And nobody thought that strange? Nobody asked him where he was going?"

Garcia shook his head. "A lot of the staff use the shuttles in their work. Coralie and Larry take a lot of flights in their survey work. And Emmett's been investigating animal life on a large island west of here. It's a long flight. Sometimes he stays overnight. There's a lot going on here, and in all the bustle, no one noticed that Arthur used the shuttle more frequently than seemed warranted. At least not until after the accident."

"But was it intentional? Couldn't it have been a mistake made in ignorance?"

"We can't rule out any possibility, not yet anyway. Myself, I think that they did do it intentionally." He looked directly at her and the frown disappeared. "The Arcadians haven't been quite as cooperative as Arthur made out. Larry's had a lot of trouble with medical exams, particularly the women. He can't order them to submit to exams, of course. He's convinced that a medical problem is keeping the population down, the Arcadians insist that it's a food shortage. Larry wanted Arthur to push for a medical program, but Arthur took the Arcadians's side. Larry was very upset about it, was hardly speaking to Arthur. He was at odds with the headman and his wife too. But you probably know all about this."

Margaret nodded noncommittally. She didn't know about any of this. It wasn't something that Arthur would have put in his report, and she hadn't had time yet to access his personal records. Open conflict within the survey team was worthy of further investigation. "But surely if Arthur was siding with the Arcadians and Larry against them, the hostility would have been directed at Larry?"

He shrugged his shoulders and the quizzical expression returned. "I don't know. None of this makes any sense. But you'll need to make your own judgments. And you'll have a chance soon enough. Tonight, Mahnou has arranged for a reception in your honor at Fo'una, the nearest village."

Margaret sat in front of the video screen, her finger tapping the scroll key as she quickly scanned the file. Now and then she went too quickly past an entry, and with a grunt of annoyance, scrolled back for a second look. Sometimes she saved an entry for further reference, more often than not discarded it and went on. So engrossed was she that she didn't hear the knock on her door, only returning to awareness of her surroundings when a polite voice said, "Excuse me."

Startled, she looked up into deep brown eyes and a handsome face with the hint of a smile playing about the mouth. "I'm Larry Montravadi. I'm a little early. I thought we'd take a leisurely walk over to Fo'una and give you a chance to get to know the survey team in a more informal situation."

Margaret hesitated, at a loss for words. "I'm Margaret Anderson, but

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you already know that," she said, extending her hand for a handshake. He took hers in his, grasped it firmly and held it a few more seconds than was strictly necessary, as if he wanted to say that for him a handshake was more than just an obligatory ritual to be dispensed with at the first opportunity.

He cocked his head, looking over her to the screen. "Positive feedback mechanism in the evolutionary development of humanoid bipedalism," he read from the screen. "Anthropology a specialty of yours?"

"Yes. My Ph.D. was in physical anthropology, at the Pan-African University in Kenya. I try to keep up, but I think it's a losing battle."

"I would have thought social anthropology or sociology more suitable for a PIA Planetary Manager."

She smiled. "That's what everyone says. But I didn't set out to be a planetary manager. Ever since I was quite young, I wanted to be an anthropologist. I started my Ph.D. thesis fully expecting to assume an academic position somewhere when I finished."

"What changed your mind?" Larry had seated himself on the edge of the table, to all appearances comfortable in what must be an awkward posture.

"Well, for one thing, there isn't much opportunity in physical anthropology any more. The digs have been played out. You've got to have an inordinate share of luck to make a significant find anymore. And if you don't, you may spend years in a stagnant career, speculating on other people's discoveries."

"And the other thing?"

Margaret looked up at him quizzically.

"You mentioned one reason," he said, "not really the most important reason. What was the real reason?"

For a moment, Margaret wondered whether a mistake in his file had recorded his specialty as internal medicine instead of psychiatry. Most people accepted her explanation and went on. She very rarely had to give her real reason, and now she found herself embarrassed to bring it out in the open. "I wanted to do something more," she faltered. "Well, actually the Morganian scandal broke just about the time I was beginning to write my dissertation. The mismanagement and the waste disturbed me. I decided that I could do a much better job than the bureaucrats, so I joined up."

"And you don't have any regrets about giving up anthropology?"

"No," she insisted, then caught herself. Why should she lie? "Sometimes. After an international meeting, when I'm reading the proceedings light-years away. But usually I'm buried under a pile of PIA paperwork and I don't have time for regrets."

Larry smiled and rose from his perch on the table. "We'd better get going. I told the others that I'd just be a minute. They must be wondering what we're up to. By the way, did you know that Arthur was an anthropologist?"

Margaret saved the entry she had been reading, logged off, then followed Larry over to the door. "I thought his background was economics."

"His degree was. But he certainly devoured the anthropology literature while he was here. That's why I was so

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curious about your interest in anthropology. I thought there might be something going on here that I wasn't aware of." Larry reached the door first and held it open for her. "Ah, the others are waiting for us."

Margaret descended the steps and found a small group of PIA staff people waiting for them. She regretted not having the opportunity to probe Larry further, to find out what lay under his last remark, but introductions claimed her attention.

"You've probably met these people in PIA files, but let me introduce them in person," Larry began. "This is Emmet Brown, our zoologist. He's been spending a lot of time on an uninhabited island not far from here, studying lizards."

Emmet extended his hand and she shook it briefly. "Amphibia, actually. We have a rare opportunity to watch the invasion of the land in an undisturbed environment. Evolution in action, you might say." Margaret experienced a twinge of envy. He had managed to find a model for evolution on Earth. Such a study would be impossible in anthropology. Human beings had only evolved once, on one planet. The experiment had never been repeated.

Margaret smiled. "I'd like to talk more about it." She turned back to Larry, who was waiting to make the next introduction.

"This is Coralc Lamar. She's our botanist and has been making some exciting discoveries in plant chemistry. She's been keeping Karl busy, at least."

Margaret shook her hand. "I thought that the native plants were toxic?"

"Not all of them. And many of the toxic ones are therapeutic at low concentrations. Several of them may have pharmaceutical applications."

"I can see that I'll have quite a bit to learn."

"And last but not least, George Brokowsky, our meteorologist. He tells us when we'll need an umbrella. Tonight, he assures us that we will not."

"That's good to know." Margaret looked expectantly at Larry. "Where are the others?"

"Mahnou Mahameha, our sociologist, and the linguist, Carlos Minata are already at the village. Karl Badin, the biotechnologist, is chained to his lab bench as usual. Shall we be off?" He paused to obtain approval from the group, then they turned and began walking towards the forest looming like an impenetrable wall in front of them. "I thought we'd walk. It's not far, and you'll get your first taste of the forest this way. And it will give us all a chance to get better acquainted." He gave Margaret a smile, as if to say that it was he who wished to become better acquainted with her. Margaret, confused by the show of attention, steered the conversation back to business.

"Do Mahnou and Carlos spend a lot of time in the village?" Margaret asked.

"They live there. We're worried that they've gone native." This last remark brought some guffaws from the rest of the group, so Margaret gathered that it was an in-joke.

"But the Arcadians have made them welcome? They don't resent the presence of . . . a . . . foreigners among them?"

"Mahnou and Carlos haven't had the

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slightest difficulty ingratiating themselves with the Arcadians."

They had reached the edge of the clearing, the edge of PIA territory. A small opening like the joint in a theatre curtain admitted them onto a trail only wide enough for two people to walk abreast. Margaret noticed that Larry contrived to take a place beside her, while the others followed behind. Was he just being friendly, or was he trying to work his way into the good graces of the next planetary manager?

Margaret slowed her pace to look about her. Under the canopy, the foliage took on a bluish cast. The air closed in on her, and a dense odor reached her nostrils, a mixture of decay and perfume, too alluring to be offensive, but too strange to be pleasant.

"You get used to the smell," Larry commented. "Actually, it's not so bad now. We've almost entered the dry season, shorsun, as the Arcadians call it. During the wet season, langsun, this place is a riot of color. It looks like a Christmas tree, there are so many flowers in bloom, and each has its own scent."

"It must be lovely," Margaret said. "It still is, in an eerie sort of way." The low thud of drums reached Margaret's ears. She bent to adjust the translator on her belt.

"How is your Arcadian?" Larry asked.

"I studied it on the trip out, but I'm not ready to trust myself in a real conversation, especially where PIA business is concerned. Most of the words seem to be derived from standard English, and the grammar is straightforward."

"Right. Often, there's a glottal stop in the middle of a word where a consonant used to be. Fo'una, the name of the village we're going to, started out as Fortuna. The internal consonants were dropped entirely. You'll have to talk to Carlos. He can tell you all about it and give you parallels in Old Welsh and Twentieth Century American besides."

Margaret laughed. "He'll probably tell me much more than I need to know. For now I'll rely on this," she pointed to the small box on her belt.

They had reached the village, set in a clearing in the forest just as the PIA compound, but smaller and in more intimate contact with the forest. Margaret could see a fire through the trees and silhouettes of people moving among the huts.

Larry stopped and turned to Margaret. "You'll be sitting at the main table, with the farspeaker Elam, and his wife. The farspeaker is a sort of bard who has memorized the history and the legal code of the Arcadians as an epic poem. His wife also has a position of authority and is held in awe by the rest of the villagers, both men and women. We haven't been able to find out just why yet."

"A priestess?" Margaret ventured.

"It doesn't seem to have anything to do with their religion, which is a rather informal version of Universalism. No, it's something more. Actually, the whole issue of women is rather an enigma to me. I haven't been able to get anywhere with them." The rest of the group laughed, and Larry added smiling, "Professionally speaking, I mean."

Margaret smiled with the others, but

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her smile soon faded. Was he a flirt? He certainly had the looks for it. If so, she had better exercise caution. She already found herself attracted to him. It wouldn't do for a PM to engage in a flirtation with a staff member.

A large bonfire blazed in the center of a circle of small but solidly built huts. Low tables encircled the fire. Beyond the circle of tables, a group of men played on drums and stringed instruments.

A native woman approached Margaret, bowed politely and motioned for her to sit at the main table, behind a huge platter of vegetables and fruits. She nodded to Elam, the farspeaker who returned her greeting with a grave smile. His grey hair gave him the impression of great age, until Margaret noticed the unlined face. He must be only about thirty-five or forty. His wife, Ana, murmured words of welcome from behind long, black hair that fell forward, casting a shadow across her face. Only her eyes, reflecting the firelight, were visible in the gloom. Margaret shuddered at the malevolence implicit in the image. Then Ana threw back her head, and her hair fell back to reveal features of provocative beauty.

"Welcome to our village," Ana said. Although her lips curled in a smile, her eyes did not follow. The effect was to convey to Margaret that she was not welcome at all.

"I am honored to be your guest," Margaret replied with the aid of the translator.

Larry sat on the other side of Ana, and the rest of the survey team took seats around the circle. Mahnou and Carlos she recognized from their file photos, not by any distinguishing features which set them apart from the Arcadians. They certainly had been accepted with no overt sign of hostility.

The disembodied voice from the translator jarred at Margaret's attention, and she turned to see Ana motioning for her to take food from the large platter in the middle of the table. Margaret watched as Ana took a piece of vegetable and dipped it into a bowl of some sort of sauce, then imitated her.

The vegetable was crisp but bland, but the sauce was piquant, with a flavor that Margaret could not recognize. She asked Ana about it.

"It is mona, fruit of a native tree. It is fresh now, but we dry it to preserve it during shorsun. It is very good, no?"

"It's one of the few edible native fruits," Larry interjected. "Try some of the red fruit."

Margaret reached out to the pile of food and took a piece of the fruit, inspecting it closely before she took a bite. "This fruit is very sweet, very good."

"It is from the almon tree," Ana said. "The fruit you are eating surrounds a hard nut which ripens during shorshun. It provides a good source of food for . . . for us."

Margaret had the impression that Ana had started to say something else, but had changed her mind. "But surely you don't rely on native food. You have crops that you can store for use during shorsun?"

"That is true. But we can always use more food. That is why we need your help. Elam says that you can bring us credits to buy food."

"That is true," she replied. "If you can find a product that can be exported,

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that people on other planets will buy, then you can use the credits to purchase things that you need."

The hard look in Ana's eyes disappeared. "That is good. We can buy food from people that are more fortunate than we, from people who have more food than they need."

"Yes, you can do that. But it is very expensive. Food weighs a great deal and you will have to pay transportation costs. You will receive very little food for your credits. It would be better to use them to buy assistance and equipment to increase your own food production. You could bring advisors here to help you. And if that doesn't work, if this planet's soil is too poor, you can be moved to a more hospitable planet."

Ana frowned. "We do not want that. This planet is a good planet. We just need more food, a little more food."

"But there are so few of you here, Ana," Larry interjected. "You grow many crops. See the food here." He pointed to women dressed in colorful sarongs who were bringing platters heaped with grilled meat to each table.

Ana smiled thinly. "Do you think we eat this way every day? This is for our guests. We are generous, no?"

"You are very generous, Ana," Margaret agreed, hoping to defuse the conflict emerging between Larry and Ana. She didn't want to start her tenure on Arcadia by completely antagonizing the Arcadians. She was thankful that Garcia had warned her about the tension between Larry and the Arcadians. "But with our help, you could eat this way every day. Our advisors could help you. But first we need to know what is wrong. That is why we have come, to learn how we can help you."

Margaret had trouble hearing Ana's reply over the chatter and laughter at the other tables. Something about helping us and leaving. Did she mean that after PIA helped, then Arcadia could be left alone? Was this an example of a colony that didn't want help? Didn't want reintegration?

"We could help you with other things," Larry continued. "You could purchase medical assistance, medicines."

"We have no need of medicines," Ana turned to look to him with scorn. "We are very healthy."

"But you have such a low birth rate, there are so few children among you," Larry said.

"There are many children here. See there, across the fire. There is Mona's daughter, and Andra'a's son, playing in front of the fire. And see the woman carrying the platter, she has *two* children."

Ana's emphasis indicated to Margaret that having two children was something unusual, quite remarkable in fact. Far from proving that the Arcadians did not have a birth rate problem, it confirmed that they did.

"That is too few for a village of this size," Larry insisted. "There are no babies, no pregnant women in your group."

"There is one. See Suza." Ana pointed to one of the tables at which a morose young couple were sitting. "She is pregnant. She will have her baby in a few weeks."

"Suza is the only pregnant woman in many villages," Larry said.

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"We do not have a problem," Ana insisted. "It is a very easy thing to explain. We do not conceive during the season of langsun. If we did, babies would be born at the beginning of shorsun, when food is not so plentiful. That would be bad for them. So we conceive during shorsun. Then babies are born in langsun. They are stronger, healthier."

"That is very wise," Margaret said. "But perhaps we could help you so that babies born during shorsun would have as good a start as those born during langsun. We could show you how to improve your agriculture, raise more food."

"That is what I have been saying," Ana said, nodding her head emphatically. "We need more food. I must go now."

The feasting was drawing to a close, everyone having reached that comfortable stage during a meal when appetite was satisfied and diners could concentrate on what they liked best of the bountiful spread before them. Ana rose from the table and walked to the center of the circle, and as if on cue, several other women followed her. Joining hands, they formed a line around the central fire. Ana led them as they moved in rhythm to the music, weaving in and out of the tables, recruiting new dancers as they passed each table.

"Well, you've just seen a perfect example of the problem we're facing here," Larry commented.

Margaret nodded but hesitated, choosing her words with care. What she had just seen was a perfect example of a PIA staff member trying to prejudice the new PM in his favor, first by engaging in mild flirtation with her, then by deliberately provoking an argument with a client. The difficulty would be to point this out to him in a way which would not antagonize him further. "You came down rather heavy on Ana, especially since we are her guests."

Rather than withdrawing in embarassment, Larry nodded in agreement. "Yes, I did. Someone around here has to. They're trying to cram this food business down your throat, and someone has to set you straight."

"You'll have plenty of opportunity to present your point of view. Preventing the Arcadians from presenting theirs isn't going to win you any favors with them or with me."

As if realizing that he had gone too far, Larry gave her a charming smile. "I stand corrected. I simply didn't want you to be hoodwinked by the Arcadian's display. Ana can put on a good show when she wants to."

"I think I'm capable of determining when I'm being hoodwinked." She added to herself, "whether by the Arcadians or by you." Then out loud, "your point about the lack of children is well taken, though. I would have expected to see many more children running underfoot at a feast such as this, unless they keep them chained in the huts."

"They don't. There aren't any. And I can't get to the women to see what the problem is. And then there's that silly taboo on top of it."

"But don't you think it might make some sense? I read somewhere that the tradition of June weddings on old Earth had a similar origin. They were unaware of the importance of sunlight for the production of Vitamin D, but they knew

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that there was a connection between the season of birth and prevention of rickets. So, have your wedding in June, and the first born would grow straight and tall. Maybe the Arcadians have a similar sort of reasoning."

"Perhaps, but there still would be more children around a village of this size, not to mention the other villages."

"And you haven't been able to get the women to cooperate? Some sort of a taboo on access to women?"

Larry shook his head. "I don't read it as a taboo, although in many similar primitive societies, women are set apart. Not so in this one. I think it's just a stubborn insistence on Ana's part that they are right and they're not going to let us find out the real reason."

"So you think there's a conspiracy, that they are trying to hide something from us?" It wasn't the first time today that Margaret had heard the conspiracy theory.

"It sounds rather melodramatic, I know, but I do think so."

"And Arthur didn't agree?" Margaret asked.

"So he wrote up that little disagreement?"

"It wasn't in his first report, and I haven't had time to get into Arthur's personal file. Garcia mentioned it to me briefly, when we were discussisng the accident."

"Well, I won't deny that Arthur and I had our differences of opinion. He was taken in by this sham. I can't understand how someone in his position, with his experience, could be so narrow-minded."

"Maybe he wasn't as narrow-minded as you think. He certainly didn't write up any of this in his first report, which indicates that he wasn't quite so certain of his interpretation as you might think. A PM, even on such a small survey as this, has a pretty tight course to maintain, between doing PIA's work and accommodating the locals. Maybe he was just trying to appear sympathetic, while keeping his mind open to all possibilities."

Larry smiled ruefully. "The voice of the bureaucrat. Perhaps I'm being too hard on him."

"If he was considering other possibilities, he might have left some notes in his personal file. Why don't we go over it tomorrow?"

"I can't object to that." He looked up. The music had grown louder, and almost all of the diners had left their tables to join the line of dancers. "We'd better join them or it will look as if we're the conspirators."

Margaret held out her hand and Larry took it. They rose, joining the end of the line as it passed their table. The rhythm was quick, but the dance step was simple enough, and Margaret found it easy to follow, although she must have looked uncommonly awkward compared to the others who moved so lightly and nimbly. She glanced around up and down the line, at the survey team members interspersed among the Arcadians, all enjoying themselves, their faces flushed with exertion and excitement. This was what it was for, why she had given up her career in anthropology, why she had joined PIA, to bring these long-sundered peoples back into the human commonwealth.

Margaret looked up at the sound of a knock on her office door and called

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out "Come in," then when she saw that it was Larry, added "you're just in time. I'm not making much headway."

Larry pulled up a chair and Margaret moved over to accomodate him at the screen. "I'm just going through his files in the order that they are listed on his directory. He has some sort of letter code on his files that seem to relate to the contents. This one seems to be a catalog of DNA sequences."

"Why would he have been interested in that? Genetic profiles of the Arcadian population, perhaps?"

"Could be, although he isn't restricting his files to humans. He has quite a bit on other primates, particularly the African apes. See, here's a comparison of the DNA sequences of primate hemoglobin genes."

"Why would Arthur have been interested in this?" Larry asked.

Margaret cocked her head and gave him a look of mock contempt. "Because it's fascinating. DNA sequences can be used to prove evolutionary relationships. Based on DNA sequences, the extinct panda bears from China were proved to be true bears instead of racoons. And although anatomical evidence suggests that humans are closer to gorillas than to chimpanzees, DNA sequencing proves the reverse."

Larry smiled sarcastically. "That doesn't answer my question. Why would a PIA bureaucrat be interested in human evolution?"

"Well, I am," Margaret replied archly.

"You have an excuse. You took your degree in it. Arthur had no background in anthropology and no reason for such an extensive collection of files."

"Maybe it was just a hobby. Informed, intellectually curious people are expected to be interested in our origins."

Larry laughed. "And ignorant morons aren't? And which category am I in? The latter, I presume."

Margaret smiled back. "Let's say that you're a good candidate."

Larry stiffened and made a face at her. "From the depths of my ignorance, it still seems that Arthur must have had a reason for suddenly developing an interest in anthropology."

"Maybe we'll find the answer in another file." Margaret reached out to hit the directory access key. "He seemed to code these files by using the first letters of a keyword. Let's try AGRI."

Sure enough, it proved to be a collection of information on tropical agricultural practices and ways to improve them. "Just what I'd expect from Arthur," Larry commented sarcastically. "There's nothing new here."

Margaret closed the file and returned to the directory. "What about PHARM?" Larry nodded and she retrieved the file.

"A lot of this was in his first report," Margaret noted.

"Yes, I've heard him discussing this with Corale and Karl. Many of Corale's plant samples were being screened for bioactivity. Karl was quite excited about some of them. He thought they might be useful as pharmaceuticals."

"Something the Arcadians would be excited about. A commodity they could sell for more food."

Larry laughed. "You're beginning to sound just like Arthur."

Margaret grimaced. "Please. I haven't made my mind up yet. Wait.

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There's a gloss on one of those codes." She stopped scrolling. Arthur had underlined one of a list of samples that Corale had collected. "PC100TX. I wonder what that is?"

"It won't be hard to find out. Corale should have it in her records."

"I'll make a note to ask her," Margaret highlighted the code name. "Why don't we move on?"

Larry returned to the directory. "Umm. TOX? Makes sense since most pharmaceuticals are toxic at high doses."

Again Margaret shook her head in frustration. Most of this file was unintelligible. "What are teratogens?" she asked, referring to a word that appeared frequently in the file.

Larry smiled broadly, evidently pleased with himself. "Well, Arthur wasn't quite as far gone as I thought. He was at least entertaining the possibility that there might be a medical problem. Teratogens are chemicals that produce birth defects."

"So he thought that a chemical might be responsible for the low birth rate?"

"Evidently. And here's our friend PC100TX. Wait. Something more. He asked Corale to collect samples of plants that flower in the beginning of langsun."

"You mean, there might be something more to this sexual taboo business?"

Larry's eyes were bright with excitement. "Evidently. There are a lot of perfumes on this planet. You can smell only a portion of them now, but at the height of langsun, the smells here are overpowering. Arthur apparently thought that one of these might be a teratogen. The old guy wasn't as lost as I thought he was."

"But how would you know for certain?"

"You'd have to send out a sample for testing, something you'd do anyway on a candidate pharmacological agent. Tests for teratogens are a routine part of a toxicological screen. According to the records in the PHARM file, Corale prepared several samples for testing."

"When would they have been sent out?"

"There's no date indicated, but Arthur wouldn't have had very much time before the first pick-up. The next one was the unscheduled one that brought you."

"So they would have been sent out on the return flight. When could we expect the results?"

"It depends on the backlog at Delta Station and on our priority number. The *in vitro* tests would only take a few days. If any of those are positive, *in vivo* tests would have to be done for confirmation. Those would take longer."

"I'll have to contact Delta and have the priority number increased." She returned to the directory. "I wonder what HOMO stands for?" When she entered the file, she cried out. "He certainly was interested in anthropology. He's collected all of the recent interpretations of the australopithecine fossil record."

"Now it's my turn to profess ignorance."

"The australopithecines lived between two to four million years ago in central Africa. There are several species that have been identified. Some lived before we see clear indications of the genus *Homo* and some anthropologists

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believe that they are ancestral to it. Others were contemporary with known specimens of *Homo*. The exact evolutionary relationships are very much open to interpretation.''

''What you mean is there's still quite a bit of controversy over the evolutionary tree.''

''That's an understatement. Arthur's involved himself in one of the most interesting and the most hotly debated topics in human anthropology.''

''Which only brings us back to my old question—why? Why would someone with a background in economics have spent so much time accumulating this file? The other files at least relate to conditions here.''

''Perhaps it does have something to do with this planet. Maybe the last file will tell us.'' Margaret returned to the directory and accessed the last file on the list, a file called NOTES ''Ah, now we may learn something.'' The file was a collection of Arthur's personal opinions as to the causes of the problems on Arcadia. In scanning it quickly, Margaret realized that Arthur, like Larry, was convinced that the underlying problem was medical. All of the rest, the food situation, agricultural practices, were extraneous.

Larry shook his shead. ''That SOB. If he was so sure there's a medical problem, why didn't he support me? Why was she misleading the Arcadians and the rest of his staff?''

Margaret shrugged her shoulders. She was just as confused as Larry. It didn't make any sense for a PIA Manager to intentionally delude his staff and the people he was supposed to be helping. It smacked of dishonesty, of deceit. Arthur had an excellent reputation. The news of his death had brought a flood of testimonials from his former PIA colleagues. Margaret couldn't reconcile their favorable opinions with the evidence before her. ''He must have had a good reason,'' she insisted.

''Wait, what's that?'' Larry asked.

Margaret stopped scrolling. ''It's a checklist of some sort.'' She read from the screen:

''Birth defects:
agent: PC100TX—tox screen
incidence in population—yes
remnant population—yes
DNA sequences—yes

''What do you suppose this means?''

Larry hestitated, then spoke slowly. ''Suppose he was trying to collect evidence to prove that birth defects are the problem. He's got a suspected agent, PC100TX, but he's not sure about it. It's been sent out for tox screen. He hasn't any evidence as to incidence among the Arcadians. Then why didn't he support me in my efforts to look at fertility?'' Larry shook his head in frustration.

''I don't understand it either. It's as if he was playing a game, publicly supporting the Arcadians while privately collecting evidence against them. And doing it behind his chief medical officer's back. Not very good business practice. And what does he mean by remnant population?''

Larry's face grew serious. ''They leave them to die, expose them somewhere?''

Margaret shuddered. ''And the lucky ones survive? How cruel. But he's written a yes after it. He must have been pretty sure of himself. Could he have

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found some of these remnants on one of his trips?"

"Perhaps, but Emmet and Corale have made trips almost as frequently and haven't found anything suspicious."

"What has he written under that . . . DNA sequences—yes. Would he have done DNA sequences on this remnant population?"

"Perhaps," Larry surmised. "And he obtained results that supported his secret theory." Larry turned and Margaret looked directly into his intense, dark eyes. "I think we'll have to find this remnant population first. And we won't find it by sitting in front of this computer."

They set out that afternoon, Larry in the pilot's seat. As the shuttle gained altitude, the PIA compound lost its significance in the vastness of the Arcadian forest. The village of Fo'una was even smaller, barely detectable through the canopy.

"What's that over there?" Margaret pointed towards the coast. "It looks like ruins of some sort."

"That's the pre-Disruption resort. Want to take a look?"

Margaret nodded and Larry obliged by swinging the shuttle on a course towards the coastline. The steel and concrete shell of a high rise hotel thrust through the forest, alien and alone. Behind the ruins stretched a series of lagoons, man-made by their regularity, on the shores of which clustered several native villages.

"Those are the fish lagoons. The villages here specialize in aquaculture."

"So that's where the shrimp came from last night."

Larry nodded. "Right. The shrimp were introduced by the consortium that ran the resort. Now these villagers raise them, trading them for vegetables and fruits that the other villages grow."

"The Arcadians made no attempt to remain in the hotel complexes after the Disruption?"

"Apparently they spent some time trying to keep things together, to maintain the resort until the relief ship came. But help never came, and at last they had to disperse, leave the security of the resort for the forest. The resort colony had made no attempt to integrate itself into the planet's ecology. I gather very little was known about it. The colony existed to serve the Imperial elite who had the money to travel this far for paradise. They built high walls to keep the forest out and used breakwalls and nets to keep the ocean out. Within were all the luxuries of a thousand planets. Imagine the money that must have changed hands at the gaming tables in an evening."

"And all for nothing. I wonder what the patrons felt when they realized that no amount of money could purchase their return."

"They never gave up the hope of rescue. The Arcadians were expecting us when we arrived, a little late to be sure. It's preserved in the farspeaker's tales. You might want to read Carlo's translations, or better yet, arrange for a hearing. I'm sure Elam would oblige you. The whole history takes several evenings to recount."

"I'll have to do that. I want to try to get better acquainted with Ana, anyway. Maybe I can make a dent in her armor."

"Good luck. And try to convince her

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and her women to submit to medical exams while you're at it."

Margaret laughed. "I'll see how persuasive I can be."

"This is about the extent of the inhabited area," Larry said. "There's one or two villages down here, but I think we'll have more luck if we head back north and go beyond Fo'una."

Margaret nodded in agreement, and Larry turned the shuttle back in the general direction of the PIA compound, but further inland. She was glad her first impression had been wrong. At the feast in the village, he had come across as arrogant and manipulative. Since then, she had seen another side of him, concerned, forthright, and good-looking, she added with a smile.

Turning away from her pilot, she peered out the side window. Below her, patches of cleared land emerged like islands in an ocean of green. In some of the fields, harvesting was in progress. What was very apparent was how few villages there were, how little impact the human inhabitants had made in the forest that stretched to the horizon. She said as much to Larry.

"Yes, it's quite noticeable from the air. It's also obvious that the population isn't anywhere near carrying capacity, and these people have lived here for several hundred years."

They continued traveling in a northeasterly bearing until the villages with their circles of tilled land disappeared.

"Any idea of what we're looking for?" Margaret asked.

"No. I thought we'd look for a likely place to set down and go exploring."

"It's too bad Arthur didn't keep more detailed notes," Margaret mused.

"Probably didn't see the need to. There's a small clearing. Let's set her down and take a walk."

Larry brought the shuttle down in a small opening in the forest canopy. They climbed out of the shuttle and Margaret's feet promptly sunk into sodden ground. "Yugh. I hope this isn't quicksand."

"There seems to be an opening there," Larry called, pointing to a break in the forest wall. "If you step on the tufts of grass, you'll be OK." He led the way through the waist-high grass until they reached the edge of the forest. It was a trail and it appeared to be made just for humans.

"How far are we from the nearest village?" Margaret asked.

"A few kilometers, I should say."

"Within walking distance," Margaret said, pointing to footprints in the soggy ground.

Larry stopped and stared, frowning at what he saw. "There's no real reason to be out in this direction. There are no fields between here and Fo'una."

"Do they look strange to you? And don't the villagers wear sandals of some sort?"

"Usually," Larry answered. "But perhaps a group of them came along the trail barefoot."

The trail led them further into the forest. It was dark, the only light reaching them having been filtered through layers of trees above them. Still, Margaret could appreciate its beauty, the fluorescent color and the overpowering scents.

They were about a half a kilometer away from the clearing when Larry stopped suddenly and motioned for her to be still. The sound of laughter, human

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laughter, reached them. What ill luck to be caught by a party of natives.

"That explains the footprints," Larry commented, as he stopped in the middle of the trail.

The noise increased and Margaret strained to detect some sense in the words, but it didn't sound like any language she was familiar with. Then it suddenly deteriorated into a cacophony of hoots and calls, inhuman in intensity and tone.

"They've seen us," Larry said.

Margaret caught her breath at what she saw heading towards her. They were not human beings. Of that she was sure. But what they appeared to be was impossible. Shorter than the average human, each had pronounced brow ridges, a receding chin, a sloping forehead and a long skull. Margaret was staring into the face of an australopithecine.

If she was disconcerted by their appearance, the reaction was not mutual. One of the creatures called out and ran towards them, holding up its hands in the gesture of greeting that the Arcadians used and calling out something that sounded very close to the Arcadian word for food.

Margaret quickly recovered her composure. Stepping forward, she smiled at them and murmured words of greeting in the Arcadian language. As if they understood, the members of the band approached, chattering and gesticulating.

"They seem to want something to eat," Margaret said.

"There are emergency supplies in the shuttle." Larry turned to head back along the trail, but Margaret hesitated, unsure how to explain their intentions to these creatures. They, however, had no doubts, but pressed past Margaret to follow Larry back to the shuttle, chattering raucously as they followed him like children following an indulgent grandparent.

When they reached the shuttle, Larry climbed inside to search for the emergency supplies, while Margaret smiled and gestured to the strange creatures before her. Larry emerged carrying several protein bars, which he distributed into the creatures' eager hands. Margaret watched in fascination as several put them directly into their mouths then grunted in alarm when they tried to bite through the plastic wrapper. She reached out and showed them how to open the wrapper, and they mimicked her readily, grunting with approval when they tasted the bars.

"Let's leave while they're distracted," Larry said. When she didn't respond, he tugged at her shirt. Reluctantly, she followed him back to the shuttle and climbed in after him. Several of the creatures had finished their bars and were gesturing for more when Larry lifted the shuttle and headed it back toward the compound.

"I think we've found Arthur's remnant population," Larry commented.

"What do you mean?" Margaret stared at him in disbelief. "Those creatures weren't human."

Larry turned to stare at her. "What do you think they were . . . relatives of Emmet's lizards?"

"Larry, those were type examples of australopithecines, our pre-human ancestors. I've seen reconstructions made from fossilized skeletons."

"Throwbacks? You're crazy. They're

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physically deformed certainly, and evidently retarded as well. I've never seen the syndrome, but they've got to be human. The Arcadians must take babies born with the deformity into the forest. Some of them survive and have formed a very primitive society, banding together to collect food and protect one another. Judging by their lack of fear of us and the expectations of food, the Arcadians must visit them regularly. That would explain the Arcadian insistence that they need more food. It all makes sense now."

"Excuse me, but you're running on just a bit," Margaret responded indignantly. "I'm an anthropologist. I've spent a good part of my life studying the fossils and the reconstructions. Those are australopithecines. They can't be anything else."

"It will be easy enough to find out. Those DNA homology tests Arthur was interested in should give us the answer. All we need is a blood sample."

"All right. We'll come back and get one, then we'll see just who's right." Larry met the challenge in Margaret's eyes with a self-confident grin, which nevertheless did not displace Margaret's certainty. They were australopithecines. They had to be. She didn't understand how or why, but she would find out. Something on this planet had caused a regression. It would be her discovery. Its impact would be enormous. It would revolutionize anthropology. She'd publish in *Galactica* of course, a short summary to establish precedence, then a seminar at the next meeting of the Interplanetary Anthropological Society, followed by a lecture tour, press conferences, a book.

She shook her head, snapping back from her fantasy to focus on the Arcadian forest beneath her. She was surprised at herself. She had thought all those dreams were safely in the past, but how quickly they had resurfaced once the opportunity presented itself. It was absurd to waste further time on such nonsense. She had given all that up for a career in PIA, a career that she found fulfilling and challenging. She had no need for adolescent daydreams. She had work to do here. The Arcadians needed her.

Margaret watched as Larry grabbed medical supplies and packed them into a small bag. "What exactly are these blood samples going to tell us?"

Larry paused before answering, as if he were checking off the contents of his pack against his own mental list. "All right. Everything's here. I'm going to do two things—the DNA sequences that Arthur was interested in and karyotyping. The DNA sequences will tell us how closely their DNA matches up to ours."

"If these creatures are really australopithecine, their DNA should match up very closely to our DNA, closer than a chimpanzee's, but not as close as another human's."

Larry smiled condescendingly. "If they're australopithecine," he conceded. "But if they're human, their DNA will match up to ours exactly."

"I know how you expect the results to turn out. What about the karyotyping?"

"Just a hunch of mine. If they're human, their chromosomes are likely to be abnormal. That's the only way to

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account for such a massive collection of abnormalities. All or part of a chromosome may be missing, or perhaps transposed. That will show up when we match up their chromosomes. I expect one pair won't be quite right."

"Like Down's syndrome?" Margaret suggested.

"Not exactly. Down's syndrome victims have an extra chromosome, three where they should have two. That gives them an extra dose of all of the genes that are on that chromosome. This in turn throws off the metabolism of the cell, leading to mental retardation, circulatory system defects, a whole host of abnormalities. Too much of something can be just as bad as too little."

"So what you are suggesting is something less drastic, not a whole chromosome, just a part of one?"

"You've got it." Larry closed his pack and hoisted it over his shoulder. "Let's go."

They left the medical building and headed across the compound to the shuttle Margaret had reserved for the afternoon. Mahnou waved as she and Arthur boarded. Several Arcadian men were with him, leaning over a shuttle control panel.

"Mahnou's keeping them under surveillance," Larry commented as he climbed into the pilot's seat. "Any further incidents?"

"No, no indication of any tampering." Margaret fastened her restraint and nodded to Larry, who activated the ignition and lifted off. The shuttle rose above the compound while Larry turned it inland, flying over Fo'una village and then beyond into the relatively uninhabited forest.

"I see from the logs that you've been taking a shuttle fairly regularly," Larry commented. "You're getting to be as bad as Arthur, going off on your own every day."

"I can't help myself. I feel drawn to them. I don't know how to explain it. When I'm out there in the forest observing them, I feel whole, complete, as I've never been before. I'm learning so much that could only be guessed at before. Larry, I think they have a language, a spoken language. It's marvelous. It's almost as if it was part of a plan, like it was meant to be. I've had regrets before about giving up anthropology, but now I feel there was a reason for it, that if I hadn't given it up and become a bureaucrat as you call it, I wouldn't have made this discovery."

She looked up to see Larry frowning at her. "Margaret, I hope you're not getting too emotionally involved in this thing. I think you're going to be terribly disappointed."

"Oh, I know what you think," Margaret tossed her head and laughed self-consciously, putting as good a front on it as she could. Larry's massive self-confidence frustrated her. How could he ignore the testimony of a trained anthropologist? When the results of the blood tests came in, she would be vindicated.

They drove on in silence until Margaret called out, "There's the clearing. I'm really trampling the grass down when I land. There's a bare patch already."

"Fortunately it probably isn't quite so obvious from the ground, or the Arcadians would know we've been here."

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Larry pulled the shuttle down and cut off the engine.

"There's another sign that we've been here." Margaret pointed to bits of foil on the ground, wrappers from protein bars that the creatures had discarded.

"One more piece of evidence to support my contention that they're human." Larry smiled at her. "They litter."

They didn't have long to walk before they saw the creatures running toward them along the trail.

"They condition easily enough," Larry commented. "Shuttle noise means food. Just like Pavlov's dogs."

"Yes, they did pick that up rather quickly." Margaret pulled some of the protein bars from the pack and began distributing them into the almost human hands held out to her in a begging gesture. She had had time to study them more closely, their appearance and their habits, and she was sure they were australopithecines. She had studied replicas of the famous skeletons, Lucy, NC1700, the black skull. She knew what they *looked like in reconstruction, and that* they would have been identical to the creatures before her. She just had to be right.

Larry signaled to her that he was ready. She reached down to take out another handful of bars.

Larry fired the stun gun, hitting one of the younger females in the group surrounding Margaret. She hooted in alarm and reached to pull the barb out, but did not associate the pain with either Larry or Margaret. She staggered away from the group, hooting softly, then dropped to the ground.

Larry ran in with his syringe ready. With practiced hands he searched for the vein in her arm and inserted the syringe. Seeing the young female on the ground, the other creatures called out in alarm, but did not prevent Larry from handling the female. They appeared more curious than fearful. One of the females approached the prone female and touched her shoulder, then fled when Larry looked at her.

"I'm almost done," Larry said as he replaced syringe barrels. The creatures crowded around Larry, poking at the prone female and extending inquisitive hands towards the syringe.

"She will be all right," he said to one of the older females in Arcadian. As if she understood him, the female moved back and settled down on her haunches to watch.

He stood up and the creatures moved out of his way. He walked over to Margaret, and the two of them watched as the creatures surrounded the female, prodding her gently, cooing to her.

"They know she's not dead," Margaret said.

"And they didn't appear to be alarmed when I worked on her. They are used to humans coming among them."

"Arthur," Margaret whispered.

They turned and headed back to the shuttle. On Margaret's previous visits, they had followed her back, begging all the while. This time, they remained around the female, calling to her.

"Well, now I have to get this back to base and do the karyotyping. I'll ask Karl to do the DNA sequences."

"What are you going to tell him?"

"Just that I've got some blood sam-

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ples I want checked out. I don't think he'll suspect anything."

"Good. I don't want anyone to know about this until we're sure of what we have."

Margaret fidgeted at her desk. Karl had said he would have the DNA homologies done by today. Why should she wait for Larry to collect the results? He had gone to one of the outlying villages and he might not be back until late afternoon. Abruptly, she rose from her desk and jabbed the save button on the keyboard. She wouldn't get anything more done until she found out.

Karl's lab was in a prefab behind the medical unit. She climbed up the stairs and knocked on the door. She waited a respectful interval, then knocked again. After another wait, she opened the door slowly, and peered around the edge to look into the lab. Karl stood at the lab bench, fiddling with the dials on one of his instruments, oblivous to the rest of the world.

"Karl," she called, rather more loudly than ordinarily necessary.

He looked up and frowned when he saw who it was. Brushing his unkempt hair out of his face, he greeted her with "What do you want?"

She suppressed a feeling of irritation at his lack of manners by reminding herself that it wasn't personal. He did this to everyone. "I've come to find out the results of the DNA sequences that Larry sent over," she said as she entered the lab.

"I'm getting rather tired of running trivial tests for you people. I have work to do, you know."

"Trivial? I don't know what you're talking about."

"Giving me human blood samples for DNA sequencing. You and Arthur both. This isn't an undergraduate biochemistry lab. I'm a respected biotechnologist with a string of papers to my credit. I don't need quality control tests." He glared at her, brimming over with indignation.

Margaret was just as indignant. Didn't he realize that he was part of a team? "Karl, I don't know what you're talking about. The samples we gave you were legitimate. We aren't engaged in any test of your skill. I have the utmost respect for you. Larry had a hunch, that's all. We wanted to test it out." Her words apparently mollified him, for he averted his eyes, resuming his work at the instrument.

"All right, but I hope you realize that I'm very busy. There's a whole new planet out there, new life-forms, new biochemistry."

"I can assure you, those samples were important." Margaret hesitated. Suddenly the implications of Karl's remarks hit her. The samples were human. She was wrong. Disappointment flooded over her. But just a minute. The samples had been coded. How had Karl identified them? "By the way, how did you know that they were human samples?"

Karl grinned, which gave a diabolical cast to his features. "If I'm going to run your silly samples, I'm going to make it interesting. I was curious as to where you obtained the samples and what you might be up to. I thought you might have discovered a new form of Arcadian life. I had the computer run a comparison with known DNA sequences."

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"And they were identical with human DNA?"

Karl nodded. "Just like Arthur's samples. So you can see why I'm just a little annoyed."

"I can assure you that the samples were important." Margaret had to tell him something, to quell any suspicions he might have. "Larry thinks that there is some sort of genetic problem accounting for the low birth rate. He thought it might show up in the DNA."

Karl shook his head. "You managers, you and Arthur, are just alike. Think you can butt into our work. All you do is waste everyone's time. Next time, explain it to me and save everybody the aggravation."

Margaret nodded contritely. Let him blame her, blame PIA bureaucrats, if it would put an end to his suspicions. She didn't want him to start questioning, probing any further into why she and Arthur had sent him samples. "Next time, I'll come to you first."

She left with a brief good-bye that wasn't answered. As she was going down the steps, she heard her name. Looking up, she saw Larry running toward her from the landing pad.

"You found out?" he called as he caught up with her. "I was right?"

Her expression must have betrayed her. She nodded. "The samples were human." She didn't try to hide her disappointment.

"Human?" Larry frowned. "Is that what Karl told you?"

"Yes. He wanted to find out what was going on. He ran an identification on our samples."

"Can't he keep his nose out of our business?"

"He was annoyed at running what he calls trivial samples."

"Let us decide what is trivial and what isn't."

"You can't blame him. We didn't tell him the real reason for running the samples. And it wasn't the first time he had run DNA sequences."

"Oh." Larry's eyebrows shot up. "The note on Arthur's checklist?"

Margaret nodded. "That's what the yes meant—that he had the results. At least we know that he was thinking along similar lines."

"Unfortunately, it's led us into a cul-de-sac."

"I should think you would be elated. Your hunch was vindicated. The creatures are human, as you predicted."

Larry smiled ruefully. "I also predicted that there would be a visible defect on the chromosome. I can't find any chromosome abnormalities. That means we've got the results of a massive chromosome rearrangement, but I can't find the cause."

"What else could it be?"

"Mutations, but there would have to be a lot of them to produce the creatures. The chances of so many mutations occurring together so consistently are astronomically low. I can't believe it's simply mutation."

"So what does that leave?"

Larry shrugged, then stared at her. "Something in the environment."

Margaret walked along the well-worn trail between the PIA compound and the village of Fo'una. The results of the blood tests had freed her from her obsession with the creatures. She had to admit now that any similarity to aus-

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tralopithecines must be coincidence, brought about by some peculiar confluence of circumstances unique to this planet. It was Larry's turn to become excited as he searched for a cause for his syndrome. He was studying them, taking notes. He planned to publish in the *Archives of Medicine*, as soon as he discovered exactly what it was that they were suffering from. Now he suspected that it was some native plant that the Arcadians ate. He was eagerly awaiting the results of the tox screen on the samples Arthur had prepared and which had been sent out when Margaret arrived.

Margaret still hoped the native women would relent and tell her something about what the creatures were, at least admit that they knew of them. She made frequent trips to the village, ostensibly to chat, to become better acquainted. She talked often to the women about children, but she always encountered the same silence on the subject of birth and babies.

She reached the village and looked about quickly. It was deserted. The villagers would be working late in the fields, to bring in the harvest lest it spoil in the fields. She walked through the village and was about to take the trail that led to the fields when she heard the sound of crying. Perhaps one of the children had become lost and couldn't find his way back to his mother. She retraced her steps, stopping before each hut to hear for the sound again. At last she found it. Remaining outside, she called gently, "What's wrong? Can I help you?"

At the sound of her voice, the crying ceased, and after some fumbling and scraping within the hut, a head peeked out. It wasn't a child, as Margaret expected, but Suza, the only pregnant woman in the village. Margaret had been introduced to her, but had never managed to elicit any response from her. In any group, she sat on the outskirts, alone and miserable.

"I am all right. It is nothing. The others are in the fields."

She moved to withdraw into the hut, but Margaret called to her, desperate that she should stay and talk. "Please, if something is wrong, if you are hurting, I can help you."

"You can do nothing for me," the woman insisted sorrowfully, bitterly.

"Do you fear for the baby? We have medicines back at the compound that can help you. We have a doctor." She stopped abruptly when the Aracadian woman shook her head vigorously.

"It is forbidden," the woman replied.

"Why should it be forbidden to seek help?"

"Ana has forbidden it." The woman shook her head. "I have said too much. You must go now."

Margaret leaned over the woman and extended a hand gently on her shoulder. "We have come to help you, to make it easier for you. If you fear for the baby, you may come to the doctor when it is your time. He will care for you."

"You do not understand. It is not allowed. I cannot. I have done something wrong and I must pay the price."

"That is nonsense. You have done nothing wrong."

"You do not understand. I . . . my husband . . . we conceived during langsun, during the time of taboo."

"But Ana explained that to me. It is

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just that the baby now will be born at the beginning of shorsun, when food is scarce. But you do not have to worry now. We are here. We can see that you and your baby have enough food."

"No, it cannot be." The woman's voice dissolved into uncontrollable sobs.

Margaret drew her closer, cradling her in her arms. "Don't worry. Everything will be all right." The words did little to comfort the woman, who continued to sob so hysterically that she gasped for breath. All of a sudden, she tensed up and looked over Margaret's shoulder.

"How may I help you?" a voice spoke from behind. Margaret's stomach twisted in fear and surprise. Turning her head around, she looked up into Ana's commanding eyes. Suza whimpered with fear.

Caught off guard, Margaret struggled to control the quaver in her voice. "I do not need your help, Ana. I came only for a chat, to pass the time."

"I am glad that you have time for such things. We do not. We must raise food for the season of need. We do not have time, like you do, to pass the time in idle chatter."

Margaret stood up and stared directly into Ana's eyes. "That is why we are here, to help you raise more food. But we cannot help you if we do not understand you, understand your needs. That is why I need to talk to you, to know you better. Dr. Montravadi, too, would like to talk to you, to understand you."

Ana laughed a shrill, bitter laugh. "Dr. Montravadi wants to poke and probe us. We women will not submit to that." She turned to Suza. "We must go back to work. Come with me, Suza. You have been idle for too long."

Margaret watched the two women walk along the trail, Suza following several steps behind Ana, reluctant to go with the woman, but afraid to defy her. Margaret cursed Ana's intervention. She had been very close to an answer. She didn't know how long she would have to wait for another opportunity.

As challenging as her new job was, it had one monumental drawback: the interim report, that compendium of three months' progress that took two months to draft, would then sit on a bureaucrat's desk at Headquarters for another three months before it was keyworded and filed. She had no illusions that someone would actually read it. If, however, she didn't prepare and release it on time, she had no doubt that she would receive a priority dispatch requesting its immediate transmittal.

So here she was, sitting before her screen, pulling together a rough draft of her first interim report. She had Mahnou's field notes on Arcadian culture, Emmet's theories on evolution, Carol's analysis of ecosystem structure and function, George's first attempts at weather forecasting. She didn't have anything from Karl yet. It didn't surprise her. Even after two pointed requests, he had failed to give her any data. She put it out of her mind for the time being, but she would have to tackle him before she was much further along. His results would be critical for her analysis of the planet's future. Arcadia's best chance of producing marketable commodities lay with the pharmaceuticals that Karl was testing. If those

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showed no market potential, Arcadia might have to be abandoned and the Arcadians settled to a more favorable location.

The creatures would not appear in her report. It was too early for any reference to them to appear on the desk of a Headquarters bureaucrat. They might leap to a premature decision about the psychological health of the Arcadians. Based on the evidence she had before her, it sounded as if they disposed of deformed infants by exposure. Headquarters might call for immediate intervention. She wasn't ready for that yet, at least not until Larry worked out the syndrome. He was very close to a solution. Let him figure it out, publish it. Then Headquarters could take over. Larry, at least, would receive the credit he deserved.

Also missing would be Garcia's suspicions about the cause of Arthur's accident. He had been unable to find any concrete proof, and since the accident the Arcadian teams had been models of industry and competence. Unsubstantiated speculations at this stage could ruin the colony's chances. A director, reading such a report from the confines of a Palmyra Office, would not see the nuances, the provisos. Garcia had done a creditable job in controlling rumors at this end. She couldn't risk an overreaction at Headquarters.

The alarm beeped from her computer. She hit the save button and switched over to audio. Any interruption was welcome.

A Comm Officer reported, "one of the shuttles is down."

Margaret's heart pounded. Larry had taken a shuttle that afternoon. "Which one?" Margaret asked.

"Dr. Montravadi's," came the Comm Officer's cool voice. "We lost radio contact with him a few minutes ago. And he's gone off the navigation net."

Margaret's voice cracked as she asked for the shuttle's last position.

"He went down beyond the village of Fo'una. We're preparing a rescue."

"I'll be right over."

She raced to the Comm shed and reached it in time to watch the rescue shuttle disappear over the trees. "Have they found anything?" she asked, her voice harsh and raspy.

"They've sighted smoke," the Comm Officer replied and switched on the audio so that Margaret could listen to the crosstalk. The rescuers had located the wreck. Larry's shuttle had gone down in a clump of trees, bursting into flame and igniting the surrounding vegetation. A request came in for a fire-fighting team.

"Why don't they say anything about a survivor?" Margaret asked.

"Not much chance of that," replied the Comm Officer. "Doubt if he had time to bail out."

Margaret resented the woman's composure. Turning away from the switchboard, she walked to the door of the shed and watched as the fire-fighting team loaded equipment in another shuttle. She had just lost a colleague, a partner, no, even more, a friend. She clenched her fists. "Damn them. Damn them," she repeated over and over.

Margaret jumped at the authoritative knock on her office door. She had been staring into the blank screen before her, thinking about the accident, about Larry, about how she might have prevented it.

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She called out an automatic "come in" and looked as Garcia entered the room. He stood awkwardly at the portal.

"I'd like to talk to you," he said.

Margaret motioned for him to take a chair. "Anything more about the accident?"

He nodded. "There was a mechanical failure in a coupler that connects the power pack with the drive module. Under those conditions, power would not be supplied in sufficient quantity to keep the shuttle airborne."

"Were Arcadians doing the maintenance?"

"They were, but one of our mechanics checked it out before Larry took off. There was nothing wrong with the shuttle when it left here."

Margaret looked at Garcia closely. His eyebrows were creased with a frown, giving him an uncertain look. "Then it was simply an accident?"

He shook his head. "It had to have been tampered with. Someone had to pull the coupler enough to make sure that it would sever connection completely in flight."

"But you said that your mechanic checked it out."

"He did. Larry must have made a landing."

Margaret nodded. "How would any of the Arcadians know where he would be touching down?"

Garcia looked straight into her eyes. "I don't know. I only know that the shuttle was OK when he left here."

Margaret rose and walked towards the window of her small office. It overlooked the bare patch of cleared land, beyond which loomed the forest of Arcadia, menacing with darkness and foreboding. Could a few Arcadians have happened on the shuttle when Larry was visiting the creatures, and seizing the opportunity, tampered with the shuttle? It sounded unlikely. For one thing, not that many Arcadians had been trained as mechanics. The chances of one appearing at just the right moment seemed remote. But the other alternative, that the Arcadians knew of their frequent landings at the site, seemed equally unlikely. Or was it? They used that clearing so often that a bare patch had been worn into the grass. And the plastic wrappers. It wouldn't take a monumental act of intellect to connect PIA with the clearing. It would simply be a matter of waiting, keeping track of flights, staking out the clearing perhaps.

The conclusion was indisputable: the Arcadians would stoop to anything, even murder, to protect their secret. They had killed Arthur, they had killed Larry, they would kill her. Margaret looked up suddenly, realizing Garcia was speaking to her. "I'm sorry, what were you saying?"

"I know it's hard to believe, but I don't think they'll stop now. I think their attacks will continue."

He had reached the same conclusion. "Why do you think so?"

He frowned, then looked intently at her. "I've been on many surveys, and a lot of them have been on planets where the humans have lost most of their awareness of technological civilization and reverted back to savagery. They're naive, like children. They're eager to learn, but hard to teach because their frame of reference is on such a low level of technology. These people are different. They seem to have retained a sense

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of technology, even though they lost the resources to maintain it themselves. They're very sophisticated. It's scary how quickly they pick up new information and apply it. If they decided to get us off the planet, they could easily obtain enough knowledge to sabotage our operations."

"But why would they want to be rid of us?" Margaret asked. "They need our help in so many ways."

"From our perspective, yes. Maybe they don't see it that way."

Margaret turned, walked back to her chair and sat down. He still didn't have anything definite. He was using his intuition, intuition based on solid experience, true, but he was missing the particular facts that would transmute his speculations into certainties. "What do you think we should do?"

"We're safe when we're in the compound. I can guarantee that. But our personnel are used to wandering where they will, either on foot or in shuttles. If the Arcadians wanted to get rid of us, it would be easy to pick us off one by one."

Margaret leaned forward. "Are you suggesting that I restrict our movements? We're a survey team, damn it. How can we accomplish anything?"

"I said restrict, not prohibit. Personnel to leave in pairs and to report destination and timetable."

Margaret frowned. Her duplicity shamed her, but she couldn't tell him that she, not the survey team as a whole, was the next target, without telling him about the creatures. She wasn't ready for that yet. In the meantime it wouldn't hurt to go along with his request. "All right. I can't take the risk that your suspicions may be justified. I'll issue an advisory that no personnel are to leave unaccompanied. And we'll start limiting Arcadian access to the compound. I don't want to ban them entirely. It may create ill-feeling among those who support us. If on the other hand, this is a general phenomenon, by limiting their access to us and increasing surveillance, we may be able to prevent further incidents."

Garcia nodded and smiled thinly. "Thank you. That's all I needed."

Margaret sat immobile as Garcia rose and let himself out of the office. She waited until she heard the click of the closing door, then covered her face in her hands. The only thing she could do for Larry now was to see this thing through, find out who sabotaged the shuttle and why.

Margaret opened the door to the biotechnology lab. Karl's fingers played busily over the keys of his console.

"Karl," she said, and at the sound of her voice, he looked up, first startled then irritated. "You said you have some results for me."

Karl pulled out a disc from a file on his desk. "It's all on here, all the data on the candidate pharmaceuticals Arthur sent for testing. Larry told me he wanted copies of the tests as soon as they came in. I thought you would want them."

Margaret took the disc he held out. "Thanks. Have you had a chance to review it? Anything interesting?"

"Well, if you're looking for toxicants, you'll have quite a list, but we knew that from the beginning."

"Larry thought there might be something on the planet, in the soil, or in the

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food that might have harmful effects on reproduction. There isn't anything here that would cause such effects, is there?''

''They don't have a problem with birth defects, do they?''

Why should Karl suspect? Why would he ask such a question? Margaret phrased her answer carefully. ''Larry never had any convincing evidence that infants were born with birth defects.'' That was true, but it was not all of the truth. Still, she would not tell Karl about the creatures in the forest. Not yet.

''I found the evidence that he needed,'' Karl said with a triumphant tilt of his head. ''Our old friend sample PC100X.''

''The chemical you were so interested in? The one that can be used for recombinant DNA research?''

''Right. Well, it turns out it's teratogenic.''

''Oh,'' Margaret said, her heart pounding. Larry had been right. There was something on the planet, some natural chemical. But would it have caused the peculiar syndrome which the creatures exhibited? ''What kind of birth defects?''

''Very interesting, very unusual. The progeny are healthy. They're just different from the parental type. It has the toxicologists at Delta station quite baffled. But it ties in with my work. The chemical can bind strongly to DNA. I surmise that when it is bound, it can express genes out of sequence.''

She turned to hide her excitement from Karl, pondering what he had just said. This was the perfume produced by the balo'on tree. And this tree bloomed during langsun. And langsun was the season of sexual taboo, when good Arcadians abstained totally from intercourse.

''Yes, that is interesting,'' she heard herself saying. She had reached the end of the lab bench. She turned around and walked back toward Karl. ''But we've never seen such defects among the Arcadians.''

Karl shrugged. ''It may be just a coincidence. But it does make for some interesting research, especially into the mechanisms of development.''

''But if it's so dangerous?''

''Only if you're pregnant,'' Karl replied offhandedly. ''Which I don't have to worry about.''

''You're continuing your research then?''

Karl nodded. ''My theory is that the chemical binds to a specific sequence of nucleotides on DNA and that this sequence acts as a control to turn on or off a whole set of genes. Any given cell in a complex organism, say a skin cell or a liver cell, contains all the information needed by that organism. But the individual cell doesn't need it all. If it is a liver cell, it only needs part of the information, the part necessary for liver cells. It doesn't need the part that's necessary for skin cells. So during development, the liver genes are turned on and all the other genes are turned off. This sequence of DNA is what controls which genes are turned off and when.''

''So if this chemical were present during development, it would prevent liver cells from developing normally, or maybe make liver cells where skin cells should be.''

''You're catching on,'' Karl extended his arm in an expansive gesture. His eyes lit up and he spoke eagerly.

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"That's essentially correct. Only this chemical is more subtle. If it were simply a matter of turning the wrong genes on everywhere, the fetus would be so abnormal it wouldn't survive. This chemical produces healthy progeny, remember. They're just different."

"How different?" Margaret asked.

"Different in unpredictable ways. Chickens exposed to the chemical developed teeth, for example. I admit it doesn't make a lot of sense."

Margaret's fingers tapped involuntarily against the lab bench. It did make sense. With mounting excitement, she took the disc. She said something noncommittal to Karl, left the lab abruptly and ran back to her office. Her hands trembled as she inserted the disc into her computer and called up the data on PC100X.

Just as Karl had said, the chemical was a teratogen, producing a plethora of defects in rabbits, rats and chickens, that baffled the toxicologists. It was unlike any teratogen they had ever encountered. To Margaret, however, the results made a terrible sense. Birds lacked teeth, but their reptilian ancestors possessed them. In developing teeth, the chickens were reverting to an ancestral state, just as humans on Arcadia had reverted to the australopithecine type. The australopithecine genes had been preserved in the human lineage, turned off until this chemical switched them back on again.

If only Larry could have lived to learn the truth. Both of them were right. The syndrome of birth defects exhibited by the creatures was none other than the ancestral characteristics of the species. This went beyond a mere explanation of the low reproductive rate on Arcadia. This provided a tool for studying human evolution itself, and beyond that, the evolutionary development of any extant species. It made the study of evolution a laboratory science.

And she, a PIA bureaucrat intent on a career of advancement and promotion within the PIA bureaucracy, who had given up a career in anthropology, had stumbled on the discovery. Before her was a discovery that would establish her reputation as an anthropologist while helping the Arcadians. She had always thought she had given up irrevocably her desires for recognition as a scientist. She couldn't say that she never regretted her decision. It had caused her much soul-searching and pain. But the rewards of work within PIA had also been substantial. Now she could satisfy both of her desires. She would gain scientific recognition for her discovery while helping the Arcadians gain a more fulfilling life.

A letter to *Galactica*, she decided, would be what she needed. She would begin it as Larry and she had begun their investigation, with a description of the physical characteristics of the creatures and their remarkable similarity to human ancestors. The DNA sequences, clearly establishing their human origins. The karyotyping, although negative data, eliminating one very real possibility. Toxicological data on the chemical PC100X, establishing it as a teratogen producing the exact combination of traits exhibited by the creatures. A brief discussion of the Arcadian's sexual taboo. A final speculation, modest and understated, on the potential that this

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chemical offered for laboratory investigation of evolution.

The clincher would have been data on the incidence of such births in the human population. This she didn't have and was unlikely to obtain now. But she didn't need it. The existence of the creatures was proof enough. The keys clacked rhythmically as she began her letter.

Instead of going to her office the next morning, Margaret walked into the forest, in the direction of the native village. She had finished a draft of her letter last night. She would let it sit for a day or two, polish it, then send it off.

The sound of sobbing came to her from the undergrowth. She stopped to listen and turned off the trail to investigate. She moved cautiously through the dense vegetation lining the trail until she came to the source of the sound—a native woman, oblivious to her approach. It was Suza, recently delivered of her child.

She gave Margaret a frightened look. Margaret placed an arm on her shoulder. "It's all right. I'm here to help you. Where is your baby?"

Suza stared at her, then broke down into sobs. "They took him. They took him." Her words were barely distinguishable.

"Where did they take him?" Margaret trembled as she hugged Suza closer. This might be the proof that she needed. "Do you want him back?"

Suza stopped sobbing and looked up at Margaret, her expression turning from sorrow to joy.

"Oh yes, could you find him for me?"

"We will go together," she said. With Suza running behind her, Margaret headed back to the compound to commandeer a shuttle. The only one remaining in the compound needed refueling, and she paced nervously as the crew overhauled it. Suza, overwhelmed by the strange surrounding, cringed in the corner of the Comm shed. Distracted by the woman's whimpers, Margaret kneeled beside her and put an arm around her shoulder. "Don't worry. Don't be afraid. We'll find your baby."

At last one of the technicians yelled that the shuttle was ready. She helped Suza into the aircar, buckling her in securely, then did the same for herself. Suza gripped the handles of the seat fearfully as Margaret took off. She gave the native woman a smile meant to encourage her, to show her that all was well, but it didn't seem to have the desired effect. Even pointing out the village of Fo'una as they flew overhead did not elicit any response. The woman was too afraid to look down.

She realized that she had no clear idea of where to go. She suspected that the band she and Larry had visited was only one of several in the area, but it was the only one she knew of. She headed in the direction of the clearing.

She landed the shuttle, got out and went around to the passenger side to help Suza. She had to lift the woman out, she was shaking so uncontrollably.

"Come along. There's a camp not far from here. We'll start our search there."

Margaret had to physically drag the woman to get her moving across the clearing and along the path to the camp.

Two females stood over the fire, poking through the coals with sticks when Margaret and Suza stormed into camp.

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At their approach, the two females called out. Their noise woke those still slumbering, and the creatures appeared, sleepy-eyed, to see what the commotion was about. When they recognized Margaret, they called out in excitement and ran towards her. A young female, perhaps in her teens, emerged carrying a baby at her breast. Suza screamed and ran toward the female.

Pandemonium broke out among the other creatures as they moved to fend off the attacker. Some threw dirt and stones, others twigs and uneaten food. Suza lunged at the girl, screaming, "That's my baby. Give me my baby."

Margaret could hardly restrain her, let alone calm her. What could she have been thinking of when she brought Suza along anyway? Even though smaller, the australopithecines were much stronger than humans, and in a group, there would be no chance of being able to take the baby by brute force. The most she could hope to do would be to reason with Suza, calm her down.

Trying to control the hysterical woman, Margaret didn't notice that the noise had died down around them. Suddenly, a strong hand gripped her arm and pulled her from Suza. It was Suza's husband.

"You should not have come. Now you must die."

Margaret turned to face Ana, who wielded a knife menacingly. "Like Arthur and Larry?"

"Like any who learn our secrets."

Margaret swallowed, forcing her voice under control. "I think it very ill-advised to do anything to me."

Ana laughed. "Do you think help will arrive from the compound?"

Margaret's heart pounded so loudly that it seemed impossible that Ana could not hear it. She spoke slowly and deliberately to control the quaver in her voice. "No, I'm certain you could kill me. I told no one that I was coming here. But PIA is already suspicious of Larry's and Arthur's accidents." Margaret permitted herself a small lie. Although PIA didn't suspect murder yet, they soon would if personnel made a habit of dying. "If you kill me, PIA will only bring down more people to investigate."

"Then we will keep killing them." Hatred flared in the native woman's eyes. "We did not ask for you to come here."

"Ana, you are part of the human community, sundered long ago in the Disruption. You have a right to be reunited with the Commonwealth."

"And what if we don't want to be?"

Margaret stared at her in disbelief. No colony world had yet refused the offer; to Margaret, it amounted almost to sacrilege. "Do you know what you are saying? This planet is a treasure of information. Scientists will come from all over the Commonwealth to study here. You will have enough credits to buy medicine, food. If you wish, you will be relocated to a planet where you can lead normal lives once again, and where you will give birth to normal children."

"And what of our children here? Do you think that we are so monstrous that we would leave our children in the hands of scientists to poke and probe and use in their experiments? Do you think we are ignorant savages that need to be shown how to become civilized?"

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Margaret paused, trying to find an argument that would sway her. "I don't think you are ignorant at all, Ana, but you are looking at this from a very narrow point of view. You do not realize the importance of what is on this planet. This is human evolution. For hundreds of years, scientists have pieced together our history from teeth, old bones and a few crudely made tools. Here is a chance to see real flesh and blood, to see how our ancestors really lived. You can't possibly realize the scientific importance of this planet."

Ana shook her head in denial. "Your words are just noises I do not understand. What I do know is that our children will become like animals to you." Ana stretched out her arm to include all the creatures in the band. "It is you who can't realize. You look at Suza's silly blathering and pity her. Why don't you pity me? Do you see that girl there? That is my child." Ana extended her arm to point out a girl standing among the women. "Today Suza is young and foolish, but someday she will understand. We are needed here. We see that they have enough food to eat. We teach them simple skills, what not to eat, how to make huts. And sometimes, when human children are born to them, we take them back to our villages and raise them as our own."

Margaret's eyes widened and she opened her mouth to speak.

"You think of them as animals, don't you? But they are human, and if they conceive during shorsun, their children are human. So you see, we can't leave them."

Of course! That was the way the chemical acted, turning off the human gene developmental sequence and turning on an ancestral one. If the chemical wasn't present, the human sequence would be expressed.

Margaret saw now why they would not leave. It was she who had the narrow viewpoint, only looking at this planet as a means of satisfying her ambitions and ignoring the Arcadians and their desires. "I joined PIA because I wanted to help others." How often had she said that phrase to her management, her peers? She looked at Ana, meeting the woman's cold gaze. How much did she really want to help others?

Margaret met Ana's glare. "I will tell PIA that you wish no interference."

"And they will accept your decision?" Ana sneered.

"They have to. It's in the Code, although no colony has ever requested it before."

Ana said nothing. After a silence, Margaret said, "I will go now to inform PIA." Defiantly, she turned her back on Ana and the knife and retreated through the ranks of native men and women who had followed Ana to the camp. She paused in front of the australopithecine woman cradling the infant that was not quite human. You could hardly tell by looking at the red, wrinkled face, but the head, there was something wrong about the head. It was too small.

She resumed her retreat and had almost reached the shuttle when she heard Ana call to her. She stopped and waited for her to catch up.

"We have booby-trapped the car. It will not fly. We will show you the way back to the compound."

"Thank you."

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Ana stared at her levelly. "It is not for you. You are right. Your PIA will become suspicious if too many people die in shuttle accidents."

Margaret settled down in the lounge chair and flicked on the terminal at her side. Accessing her research file, she flipped through the references until she came to the one she wanted—the proceedings of the Interplanetary Anthropological Society. There was enough here to keep her busy for the entire return flight to Palmyra and on to her next assignment. Noting a paper by Jahn, she reached out to call it up, when a hand pushed hers away from the keyboard.

"Do you think you'll get away with this?" Karl asked her. "I was on the verge of a major breakthrough."

She looked up at the hostile features of the biotechnologist. "It wasn't my decision, Karl."

"But it was made on your evidence, without any consideration for anyone else. Do you have any idea of the scientific importance of what I was working on?"

"Oh, Karl, I do," she thought, "but I'll never be able to make you believe me." Out loud, she said, "There were considerations more important than scientific inquiry."

"Just the answer I'd expect from a PIA bureaucrat."

Margaret refused to rise to the bait.

"Don't think you've silenced me, though. I know the identity of the chemical I discovered on Arcadia, and I can have it synthesized. I can't be stopped so easily." Karl turned on his heels and left the lounge.

Margaret returned to the screen but her nerves had been distracted as well as her attention. Her fingers shook as she called up the paper. Jahn was an expert on speech simulation in primates. Forcing her attention on the paper, she calmed down as she read it and the ensuing debate over the parameters that Jahn had used in his simulation. Other scientists did not accept his conclusion that australopithecines could have developed a primitive language. "We'll never really know for sure," he said in reply to his critics, "but we can make some educated guesses."

"Oh, you're wrong, Jahn, you can know, you can." The screen blurred and Margaret rubbed the water out of her eyes. After so long in the forests of Arcadia, she wasn't used to recycled air. ■

● No passion so effectually robs the mind of all its power of acting and reasoning as fear.
Edmund Burke

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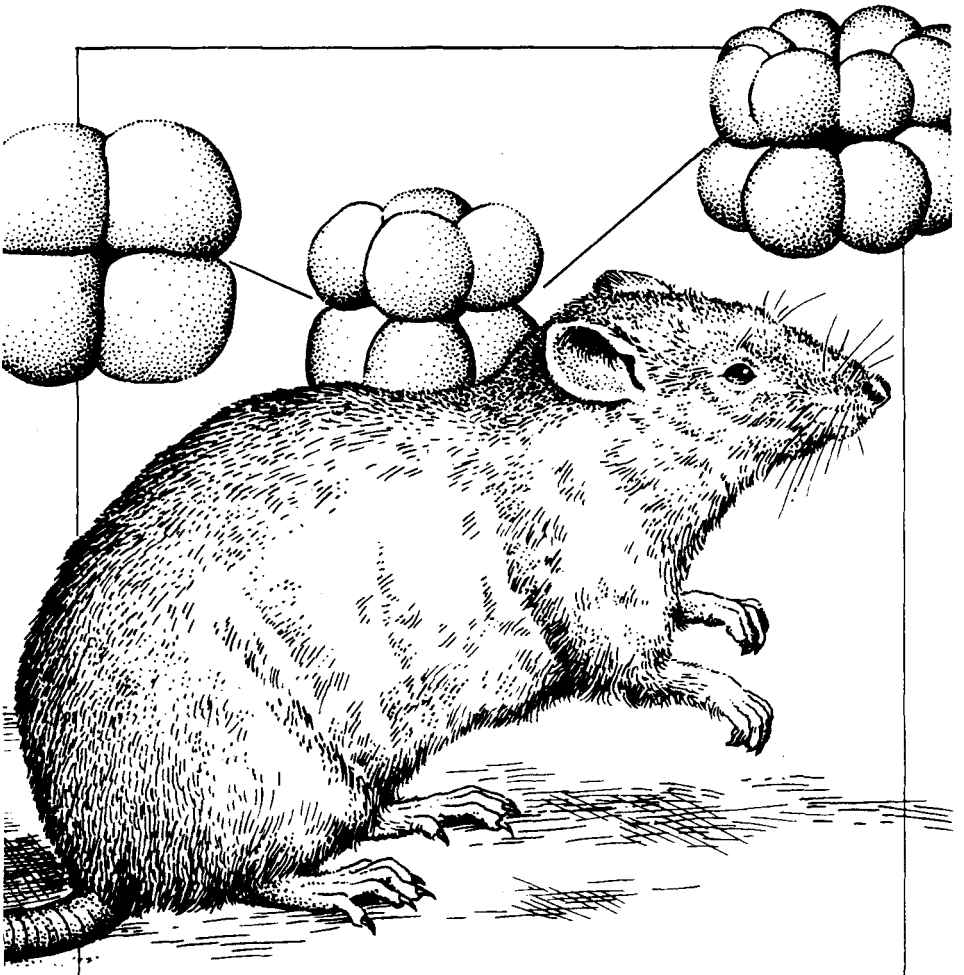

SIDE EFFECT

Roger MacBride Allen

By the nature of this thing,
I can't be sure it
hasn't already happened. . . .

Bob Walters

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Even before Schmengee and Portafoy came into my office, I knew I had a problem. There had been leaks, major leaks, concerning the Trimalicine-3 project. Every magazine, every newspaper, every television network had reported on the accidental discovery of the original Trimalicine compound. They had all drawn the obvious parallel with the discovery of penicillin. Except Trimalicine-1 was supposed to make the penicillin breakthrough look like a cure for chapped lips. By the time Schmengee and Portafoy had refined it as far as Trimalicine-3, the stuff was rumored to cure everything but the national debt.

I say "rumored to" because even *I* didn't have the details. Ours is one of the largest commercial pharmaceutical firms in the world, with a research establishment to match. But commercial drug research is kept very quiet, as a rule. Industrial espionage reaches its fullest flower in the drug business. Rumors were flying everywhere, but hard information just didn't exist.

Even the rumors and guesses were enough to drive the stockholders and the board of directors crazy. All of them had dollar signs in their eyes. Barely a day went by when I didn't get phone calls wondering "how soon" Trimalicine-3 would go public.

And then one fine day came the memo from Antoin Schmengee, Ph.D., head of research, countersigned by Yolanda Portafoy, his top assistant. Three lines of print, advising that "Trimalicine-3 has no medical or commercial application." Which was of some interest to me, to put it mildly, as accounting was projecting a potential market in the tens of billions. Maybe Schmengee and Portafoy wished that I would accept their memo and leave it at that, but I doubt they held out great hopes.

In any event, the two of them didn't seem surprised at the "invitation" to meet me in my office the next morning. Reluctant, perhaps, but not surprised. Like patients who knew perfectly well what the dentist was going to find.

They filed in, rustling a bit in their white starched lab coats, Portafoy in the lead—a tall, bird-like woman, today seeming strangely nervous. A wild smile flashed on her face and then disappeared, as if she knew a joke she couldn't tell in this company. Schmengee followed her in, a short, rotund figure with coke-bottle glasses, a bald pate and a greying beard that looked wiry enough to scour pots. Even Schmengee, generally one of the most self-possessed men you could ever hope to meet, seemed oddly distracted. He was carrying a small white cardboard box, which he held carefully on his lap when he sat.

Portafoy had to do most of the talking. We got through the motions of socially polite behavior, and then sat there in pointless silence, all three of us, waiting for someone to begin. It was Portafoy who finally launched into what she clearly regarded as an indelicate topic.

"For starters," she said, "Trimalicine-3 works. It cures what ails you. It's a general restorative and cure for practically everything. It fulfills all the promises that Interferon made, and then some. *Why* it works, *how* it works—ask me in ten years. We've studied it, refined it, purified it. We've run all sorts

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of tests, and all we know for sure is that it *does* work. Not why.

"We tested tissue cultures first, dosed with everything we could think of. We tested it against all the diseases we could come up with, and it whupped 'em all. It seems to work not by killing the disease organism, but by causing the afflicted tissue to be healthy, to renew normal function and development in the presence of the disease agent. The disease organism eventually just gives up and goes away. That may not make sense, but that's what seems to happen. We couldn't find any side effects, any drawbacks.

"It seemed like it could do no wrong, do no harm, but we wanted to be *sure*. If we didn't understand why it worked, we wanted to know everything about *how* it worked and what it did before we tried it on humans. Thank God we were cautious. We tried every germ- or virus-induced disease we could find, dosed our tissue cultures with every kind of illness. The common cold. Pneumonia. Diphtheria. AIDS. It beat them all. Then we tried it against malignancies."

"And it didn't help? It made cancer worse?" I ventured. Whatever was upsetting these two had to be pretty bad if it could mess up the pretty picture they were drawing.

"It made cancer disappear," Schmengee said with a slight tone of contempt in his voice, either for me and my stupid question or for the weak-willed cancers his Trimalicine-3 destroyed so easily. "Any cancerous tissue culture we treated with it immediately reverted to normal health." He paused for a second. "And then some."

"*More* than normal health," Portafoy agreed. "You see, any tissue culture maintained in the lab, in the test tube if you will, tends to lose what I like to call adaptive structure after a while. Our treated cells began to *regain* structure."

"Structure?" I asked.

"A muscle cell in the body has to act like a muscle cell to survive. Not in the test tube. Anything goes." Portafoy explained. "Once they're out of their body-environment and start soaking in nutrient, they don't have to work for a living. So the cells get out of shape, lose the specializations they needed to survive and function as part of a body. Cells tend to generalize *in vitro*. They get generic, revert to formless amoeba-like cells."

"But not your treated cells," I guessed. "New tissue cultures didn't revert. They held adaptive structure." What was so bad about that?

"Even old cultures were affected," Schmengee grumbled. "Fully reverted cells, even malignant cells whose ancestors hadn't been inside a human body for hundreds of generations, rapidly regained their perfect in-body form once they were treated with Trimalicine-3. Malignant descendants of liver cells, lung cells, muscle cells, shed their cancerous condition and returned to their ancestral form, even if their lines had survived only as cell cultures for decades."

"But what's wrong with that?" I asked.

"What's wrong with that," Schmengee growled, "is that up to now we're talking human cell cultures. The damn stuff works even better with rats."

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"Rats?" I asked. How the hell did we get around to rats?

"Rats," Schmengee said. "We tested it on lab rats, of course. A few living, breathing rats, but mostly on the standard rat cell cultures. The *standard* rat cell cultures," he repeated, as if defending himself against some anticipated accusation of using cheesy, off-brand cultures.

"The standard cultures," Portafoy agreed in a gentle voice, as if trying to draw Schmengee out, trying to get him around to the central point. "On rat cultures, it had—had an even more dramatic effect than on human tissue. Didn't it, Professor Schmengee?"

"Damned impossible," Schmengee muttered. "What happened *couldn't* have happened."

"But it did happen, professor," Portafoy said softly. "It did."

I could feel my blood pressure rise, and wondered if Trimalicine-3 would cure impatience, too. These two were going to pussy-foot around the problem all morning. "*What* happened?" I demanded.

"It was the malignant fetal rat tissue at first," Schmengee said in a voice that was suddenly quiet and thoughtful. "That's the only culture that's come to term yet. I suppose that makes sense, somehow. But the other rat cultures are on the way."

Portafoy waited a decent interval, giving her colleague the chance to go on with the story. But Schmengee seemed completely lost in thought. He wrapped his hands protectively around the small box on his lap and shook his head.

Portafoy concluded that her partner wasn't capable of explaining himself further and sighed. "In fetal rat cell tissue cultures, Trimalicine-3 has an even more pronounced regenerative effect. You could say it induced cloning. It cured the cancer in the fetal tissue—and then—and then a *blastula* formed. The hollow ball of cells that is the first step toward creating a, ah, fetus. Then, somehow, the blastula induced the rest of the surrounding fetal tissue to reorganize itself, to deliver nourishment for the growing—organism."

The skin on the back of my hands began to crawl. "Just how far did this go?" I asked worriedly.

Portafoy ignored my question and continued speaking, looking straight ahead, quite obviously unwilling to make eye contact. "The blastula grew, and somehow found a way to attach itself to the side of the nutrient rack. That should have been impossible, too—but there were a whole series of impossibilities concerning the entire situation. Other than providing continued nutrient and transferring it to a larger container as the—the *growth* got bigger, we didn't interfere with its development."

I looked down at the box on Schmenee's lap, and realized that I could hear a faint gnawing noise coming from inside it. "*Just how far did this go*?" I demanded.

Schmengee looked up with a start and blinked at me. "Why, all the way, of course. That's why we're here. And, by the way, every living female rat we've tried Trimalicine-3 on is not only fully cured of whatever it had, it's pregnant. None of them have been near a male."

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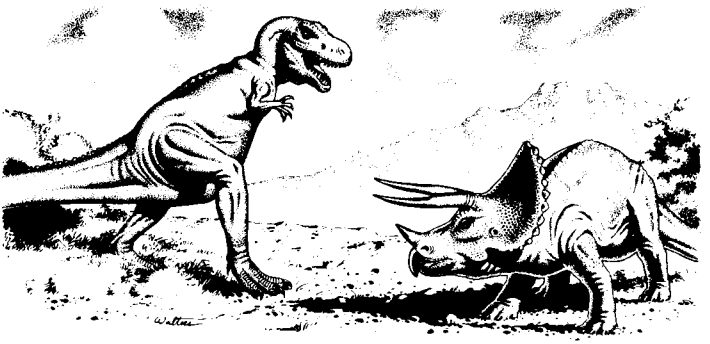
Schmengee shrugged. "I assume it's a related phenomenon. *You* figure the moral questions."

He picked up the box, placed it on my desk, and removed the lid. Inside was quite a handsome little fellow, brown-furred and bright-eyed. It dropped the nut it had been chewing on and looked up at me. "Here's how far it got," Schmengee said. "Hand-raised, of course. After we decanted it, we fed it milk through an eye-dropper." Schmengee stood up, put his hand into the box, and scratched the little fellow behind the ears, his facial expression equally divided between affection for the animal, and stunned shock at all the implications. "The non-fetal rat cultures seems to be responding the same way the fetal samples did, though more slowly.

"We can't tell you if the human cultures will respond the same way, because we don't want to find out. I incinerated all the human cultures myself and destroyed the work records." He picked the baby rodent up gently and offered it to me. I reached out a hand automatically, and took the creature in my palm. I could *feel* the life there, the busy heart, the twitching whiskers, the ticklish sensations of tiny warm feet on my palm. It sat up on its hind legs, and bright, twinkling eyes returned my gaze.

"The real question," Schmengee said, "is how do we explain to the public and the medical societies that they can't have Trimalicine-3 because it causes rats in laboratory cancer?" ■



● Men fall into a routine when they are tired and slack; it has all the appearance of activity with few of the burdens.

Walter Lippmann

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The Alternate View

THE TWIN PARADOX REVISITED

John G. Cramer

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Six months ago I wrote an Alternate View column about wormholes, faster-than-light travel, and time machines. It was based on a spectacular recent breakthrough in general relativity from a group at Caltech. The column described how an advanced civilization might construct a stable "wormhole," a transspatial shortcut between one region of space and another, and use this shortcut for both faster-than-light travel and time travel.

Shortly after the column appeared in *Analog* an irate letter arrived from a regular reader with a good background in physics. He complained that one of the points made in my wormhole column was physically incorrect. He demanded that I correct this serious mistake and set the record straight with a printed retraction. This reaction, in itself, isn't unexpected. FTL and time travel are very controversial topics that lie well outside the usual "circle of discourse" of contemporary physics. Even though they are now moving toward this circle of discourse, some objections are to be expected.

However, the complaint was not about FTL or time travel. The reader objected instead to my reference to the *twin paradox* of special relativity. In the wormhole column, I had stated (correctly) that if a space ship made a round-trip to a point 0.866 light-years distant while traveling both ways at 86.6% of the velocity of light, the ship's clock at the end of the trip would read one year slow as compared to a clock that remained behind and at rest; astronaut *Sam* making the trip would age one year while his twin brother *Ernest* who had remained behind on Earth would have aged two years. It was this allusion to the twin paradox which had prompted the letter.

The relativistic twin paradox, the slowing of biological clocks by relativistic time dilation, and the differences in aging thereby produced are not new in science fiction. They provide the

	Ernest's System			Albert's System		
	E's Clock (Years)	S's Clock (Years)	A's Clock (Years)	E's Clock (Years)	S's Clock (Years)	A's Clock (Years)
Start	0.0	0.0	0.0	0.0	0.0	0.0
Turnaround	1.0	0.5	0.5	0.25	0.5	0.5
Finish	2.0	1.0	1.0	2.0	1.0	4.0

Underlined numbers indicate clocks at same location

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premise for many excellent SF works: Joe Haldeman's *Forever War*, Poul Anderson's *Tau Zero*, and Ursula LeGuin's *Rocannon's World* are examples.

There was no physics goof in the use of the twin paradox in the wormhole column, but the irate letter points up an interesting fact. The twin paradox is still, some 85 years after publication of Einstein's paper on special relativity, not generally understood. Therefore, I've decided to devote this column to an exploration of the twin paradoxes of both special and general relativity.

The "fixed" Newtonian quantities of mass, length, and time become *variables* in special relativity at a veolocity (**v**) that approaches the speed of light (**c**) or when the ratio **v/c** approached a value of 1. An observer at rest will see three amazing changes in an object moving past him at a velocity **v** not much less than **c**: (1) the object's mass increases; (2) its length shrinks along its direction of motion; and (3) its internal clock slows down. All of these variations can be calculated by applying the same "Lorentz factor" from special relativity, often represented by the symbol *gamma* (γ) and defined by $\gamma = \mathbf{1/Sqrt[1 - (v/c)^2]}$.

In considering the twin paradox, let us focus on relativity effects that occur in the particular case when **v/c** = 0.866 (**v** is 86.6% of **c**), a velocity at which the Lorentz factor γ is exactly 2. At this velocity exactly half of the mass-energy of the moving object comes from its mass-energy at rest and the other half is kinetic energy. In other words, acceleration must supply an amount of energy equal to the object's rest mass $\mathbf{m_0}$ giving it a kinetic energy equal to $\mathbf{m_0c^2}$. At this velocity the mass **m** of the moving object is doubled ($\mathbf{m = \gamma m_0 = 2m_0}$), its length **L** along its direction of motion shrinks by half ($\mathbf{L = L_0/\gamma = L_0/2}$), and its clock takes twice as much time **T** between ticks ($\mathbf{T = \gamma T_0 = 2T_0}$) and therefore runs slow by a factor of $\mathbf{1/\gamma}$ or half it's speed at rest.

Much of the confusion surrounding the twin paradox can be traced to two specious arguments. Argument 1, which might be called the **symmetry argument**, usually goes like this: *"Observer Ernest, who remains behind and at rest, will observe that astronaut Sam on board the ship travels away at a speed* **v** *and then returns at the same speed. But Sam also observes that the stay-at-home observer Ernest travels away from him* at speed **v** *and then returns at that speed. Sam is just as good an observer as Ernest, and since each observes the other having the same velocity relative to himself, there can be no difference in the readings of Ernest's clock and Sam's clock when the two clocks are compared at the end of the trip."*

Argument 2, which might be characterized as the **know-nothing argument**, usually goes like this: *"The Lorentz transformations of special relativity only apply to objects traveling with* constant *speeds. But space ships must accelerate and decelerate in their operation. From the equivalence principle of general relativity we know that acceleration is equivalent to the effects of gravity and that gravity must be handled with the elaborate mathematical machinery of general relativity. Therefore, the twin paradox cannot be ana-*

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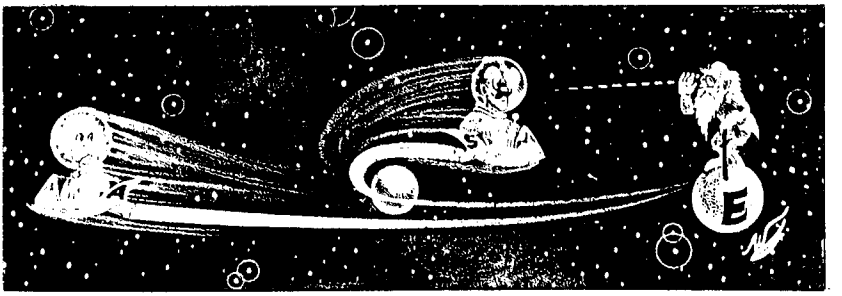

Illustration © 1990 by William R. Warren, Jr.

lyzed with special relativity alone, and we can't simply use the Lorentz transformations to say what the two clock readings will be after the trip. If there is *any difference in the clock readings, it arises strictly from general relativity effects.*"

Both of these arguments are wrong. Let's take the symmetry argument first. The Lorentz transformations of special relativity on which the twin paradox is based assume that the set of observations of mass, length, and time is made from one *inertial reference frame*, one coordinate system that is either at rest or is moving with an unchanging speed in a particular direction. Clearly, observations do not have to be made from an inertial reference frame, but if they are not, the Lorentz transformations don't directly apply. The significance of this is that the system of observer Ernest is an inertial frame, while the system of observer Sam is *not* an inertial frame. Sam is not in an inertial frame because in mid-trip his ship's engines were used to accelerate him and to reverse the direction of his velocity for the return leg of the trip. If one constructs *world lines* for the two observers by plotting space position against time position on a piece of graph paper, the world line of Ernest is straight, an indication that he is in an inertial frame. The world line of Sam, however, has a kink at the place where the ship's acceleration takes place, an indication Sam is *not* in an inertial frame.

Therefore, the seeming "symmetry" between the systems of Ernest and Sam is illusory. Their observations are not equivalent because Ernest observes from an inertial frame while Sam does not. Can we analyze the problem from the point of view of Sam? We can for part of Sam's trip by using the point of view of an observer *Albert* who goes out with the ship on which Sam travels, but continues to travel on at the same speed in the original direction after Sam's ship turns around and comes back. Albert sees Ernest moving away at $\mathbf{v/c} = 0.866$. Half a year later, after Ernest has traveled .433 light-year (because for Albert the 0.866 light-year distance is contracted by a factor of 2), Albert sees the ship with Sam aboard accelerate to $\mathbf{v/c} = 0.9897$ (corresponding to $\gamma = 7$) and race after Ernest. [This velocity comes from relativistic velocity addition: $\mathbf{v} = (v_1 + v^2)/(1 + v_1 v_2/c^2)$.] It takes 3.5 years for Sam to catch up with Er-

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nest. The whole episode takes 4 years according to Albert's clock. However, Ernest's clock runs slow by a factor of 2, so it will register only 2 years. Sam's clock read 0.5 years when it accelerated to catch up with Ernest. Catching up with Ernest required 3.5 years, and during that time Sam's clock was running slow by a factor of 7, so that it recorded only 0.5 years of elapsed time. Therefore, Sam's clock registered a total elapsed time of 1 year as compared to 2 years on Ernest's clock. This is the same result as before, even though it was observed from a very different perspective.

Notice, however, that *all* the clock readings do not match. From Albert's point of view, Ernest's clock reads only ¼ year when the ship accelerates to turn around. From Ernest's point of view, his own clock reads ½ year when that acceleration event occurs on the ship. But Ernest's clock was at a large distance from Sam when his ship accelerated, so Sam's clock and Ernest's clock cannot be placed side by side for comparison. In special relativity separated clocks need not have the same relative readings in all systems. This is the reason that in relativity two separated events can be said to happen at the same time only in reference to a particular reference frame. There was a ¼ year difference in relative clock readings in the scenario above depending on whether Albert or Ernest did the observing.

The "know-nothing" argument given above is wrong because its basic premise is incorrect. The formalism of general relativity is *not* required for dealing with acceleration. Special relativity works fine for accelerating objects, as long as the Lorentz transformations are based in a reference frame that is *not* accelerating. One simply allows object's velocity to change with time. You can think of the process as breaking up the acceleration into little time intervals during which the velocity has a certain average value, and then apply the value of gamma appropriate to that velocity in that time interval. This may require some calculus, but it doesn't require general relativity, which deals with the effects of gravity fields.

However, general relativity does provide us with another way of thinking about the twin paradox. According to general relativity, a clock runs slower in a gravitational potential V by a factor of $(1\text{-}V/c^2)$. This means that a clock on the surface of the Earth runs slower than an identical clock in gravity-free space by a factor of $(1 - 6.60 \times 10^{-10})$. In one year of running, the earth-based clock would lose 20 milliseconds.

Now consider a thought experiment. Suppose that for a period of one hour, a cosmos-wide 1,000 g gravitational field switches on over the whole observable universe, and then switches off again. Everything in the Universe will free-fall in this field, gaining enormous velocity and energy. What are the observable consequences of such a cosmic event? The answer is: *none*. Since all objects in the Universe would accelerate together, there would be no observable clues that the gravitational field is even there. It would be as if it had never happened.

Because switching on and off such a field has no observable consequences, we can pretend it is happening to deal with acceleration. In the case of Sam

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and Ernest, suppose that a Universe-wide gravitational field switches on, but astronaut Sam, determined to maintain his ship's position, uses its engines to counteract the force. Sam stays at a fixed point. He experiences a force pulling him in the direction of the field, but he remains at rest. Then, after his twin brother Ernest, who is freely falling in the field, reaches $\mathbf{v/c} = 0.866$, the force switches off, and Ernest continues to move away from Sam at that speed. After half a year, the force switches on again, this time acting in the opposite direction for twice as long, and Ernest's velocity is reversed, bringing him back to Sam's ship. Sam always uses the engines to hold his fixed spatial position. Finally, the force switches on one last time to bring Ernest to rest with respect to Sam at the same posititon. Ernest has never observed any acceleration, since he was always in free fall. From his point of view, Sam used the ship's engines to accelerate away from him, travel 0.866 light-years, and return.

Do their clocks match now? During the initial acceleration and deceleration, Sam and Ernest were in the same gravitational potential, so no clock differences were produced. During Ernest's trip away and back, he was moving at $\mathbf{v/c} = 0.866$ and so his clock is slowed down by a factor of ½. But at the distant turnaround point, when Ernest is decelerating and reversing his velocity, Sam was in a gravitational potential that is larger than Ernest's by an amount $\mathbf{aL}$, where $\mathbf{a}$ is the acceleration produced by the uniform gravitational field and $\mathbf{L}$ is the distance between Sam and Ernest. During the time the uniform gravitational field is switched on, Ernest's clock runs faster than Sam's clock by a factor of $(\mathbf{1 + aL/c^2})$. The result of this gravitational speedup is that it puts the Ernest's clock precisely one year ahead of Sam's clock when he returns, just as before.

It's comforting, but not particularly surprising, to find that special and general relativity give the same answer for the twin paradox. The conclusion is that Sam, the twin who feels the force pushing him against the floor, ages less than his twin Ernest, who can remain in free fall or zero-g the whole time. So when you feel the pull of gravity on your aging bones and muscles, consider that because of it you're actually aging less (if only by 20 milliseconds per year). ■

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Relationships between humans and aliens will, of course, be shaped by their respective natures—which means they will be both complicated and very dependent on the acts of individuals.

BACKLASH

W. R. Thompson

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How smart is your typical mugger? It depends. The bright ones make a living at it, and don't get caught. The average ones end up doing hard time in Attica. The dumb ones end up in the morgue, either because they picked a victim who could fight back or because they went one-on-one with the New York Police Department.

And then there was Freddy Waleski, who tried to rob the huxloni ambassador. I still can't decide if he was a genius or a moron. A little of both, maybe—he might have gotten away with it, if he'd lived. And if he'd known he was being used.

It was a February morning and it was snowing, which usually drives the street hoods into the subways. I was in my office when the desk sergeant buzzed me. "Lieutenant Prynne, you'd better look at this one."

"What have you got, Muldoon?"

"Lieutenant, you had better handle this." She sounded unhappy. That alerted me; genjees are wired to handle stress. "It's something new."

"I'll be right out." I sighed. I love doing meaningless paperwork; at least, I like doing it better than certain other things, and getting saddled with a sticky legal situation is one of them. On the other hand, twenty-nine years on the force has taught me that life is just one problem after another. I put the report aside and left my office.

The booking area was crowded, as always. I had to force my way to the desk, where Muldoon was staring down at a grubby, beat-up punk, two uniformed officers and an ugly guy in a brown fur coat. All four had a heavy dusting of snow. "You can't flush me!" the punk was telling Muldoon. "I know the law!"

I didn't catch Muldoon's reply; I'd just realized that the "ugly guy" was huxloni and the coat was his natural pelt. I've dealt with them before; their enclave is in my precinct. The huxloni don't make trouble, but the chauvs don't want them around. Until now we'd only had to deal with nuisance calls, mostly due to the Human Brotherhood picketing the enclave and blocking local traffic. This was the first case which directly involved an alien.

I got my brain in gear and recognized this one. His fur was mottled brown, with a black *V* running from the bridge of his nose—well, from between his eyes, up over the top of his head. That could only mean he was the ambassador. "Mr. Grauw," I said, shaking his hand. It's an odd sensation, shaking a hand with two fingers and two thumbs. "What's the problem?"

The punk opened his mouth first. "That thing killed Freddy!"

If Grauw took offense, I couldn't see it. "I did," he said. "I was accosted for my possessions." He patted his belt-pouch, which was all he was wearing.

"Great," I muttered.

"No, regrettable," Grauw said. His tail lashed emphatically. "This incident may hamper our dealings."

I looked at the uniforms. They'd been sent out on zombie patrol when the storm started—a routine job, looking for derelicts asleep in the park, and bringing them into the shelters before they froze. "What did you see?" I asked.

Officers Wendell and Hamlyn both

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shook their heads. "We only saw the tail end—uh, the last of it," Wendell said. "Jake and I heard shouts and went to investigate. We saw the ambassador deck powermouth, here, and start to walk away. We stopped him."

"You did the right thing," I assured them. Both men looked uneasy. Grauw was a diplomat, after all, and rookies are never at their best in peculiar situations. "So what went down?"

Hamlyn looked happy to be back on known ground. "Two punks tried to mug the ambassador." He pulled out his note pad, switched it on and read. "Our perpetrator is Joseph Edward Putnam. His accomplice was Fredrick Waleski. Both of them had switchblades. Waleski is dead, evidently from a crushed chest. Putnam got the wind knocked out of him, but a paramedic scanned him and found no health-threatening injuries. Crime Scene Squad took charge of the site and we brought in Putnam. We've advised him of his rights." He put the pad away.

"So, Lieutenant," Muldoon said, pointing at the punk, "Do I book this, or what?"

"You can't book me for nothing," Putnam said. His hands were cuffed behind him, so he nodded his head at Grauw. "That thing ain't a legal person. The Handyman case." The little slime looked smug. "You know. Some lab made those freak monkeys and tried to say they was as good as humans. The Supreme Court says only humans got human rights. Ev'rything else is just a animal."

"Guess again," Muldoon told him. She ran a hand through her frizzy black hair. "Handyman doesn't apply. The Court took judicial note of the huxloni's legal human status last year."

I nodded. "Book him for armed assault, possession of a deadly weapon and homicide—"

"Murder!" Putnam yelped. "I din't kill no one!"

"Waleski died during the commission of a felony," I said. "You were involved in the crime. That makes you culpable."

Putnam's face went red with anger. "Me and Freddy just wanted its pouch! We wasn't going to hurt no one!"

I turned my back on him. "Mr. Grauw, why don't we talk in my office?"

"Certainly." He brushed some snow from his pelt. "May I make a call?"

I nodded. "But I don't think you'll need a lawyer."

"Not to a lawyer." Grauw followed me into my office and picked up the phone. "I did have an appointment at Columbia University, to attend a xenology seminar. Courtesy requires that I call them."

Grauw paced back and forth as he made his call—impatience, I suppose, as he was put on hold. Melting snow dripped from him onto the rug, which quietly absorbed it, heated it and returned it to the air. I saw to my relief that Grauw was wearing rubber pads on his hooves; otherwise their edges would have razored the rug.

Finally he got to tell some professor that he'd been involved in a crime, that he had killed a human in self-defense. Would he attend the seminar? He looked at me.

I shook my head. "I'd advise against it."

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He told that to the professor. "Please convey my regrets . . . I thank you for your concern. . . . Yes, it is unsettling, but the incident may give insights into your culture. I shall be happy to share them. . . . Good day." He hung up. Maybe I was misreading him, but Grauw didn't seem unsettled by what had happened.

He took a chair and sat—on its edge, as much to accommodate huxloni body posture as the tail. "I have no familiarity with this," he said. "How do we begin?"

I got out a note pad. The computer was recording everything, but taking notes helps me think. "Let's start with what happened."

Grauw nodded. "I was walking through Central Park when the two humans accosted me. They displayed knives and demanded my pouch, and then attacked. I protected myself, knocking down both men. One died, but the other did get up and again attacked me. I again knocked him down, stunning him. Then the officers appeared."

I looked up from my notes. "They say you were leaving the scene of the crime."

"I did think the incident at an end, and I did no wrong."

"You still had to stay around. That's the law."

"I see. You need to account for the presence of dead or unconscious persons."

"Exactly." I didn't mention something else: we might need to prove that everything was as it seemed. I knew exactly what the human chauvinists were going to say about this incident. Alien monster attacks poor, innocent youths. "You did pretty well against two-to-one odds. Do you have any martial arts training?"

" 'Martial arts'? Ah. No, I have no special fighting talent. However, human reflexes are more slow than ours, except for your genetic-enhanced individuals. The odds favored me."

"But it was still dangerous," I said. "Did you think about running away from them?"

"No. They appeared on both sides of me, from behind large shrubs." I think he was chagrined. His face and hairy, pointed ears were twitching. "If it matters, I did not mean to kill, but I was unaware of human frailties."

"You're not at fault there," I said. "But could you tell me something? It's a long way from your enclave to Columbia. Why did you walk?"

"I did have the time, and I enjoy visiting Central Park." More twitches. "It seemed a pleasant, rather homelike day for a walk. I allowed my enjoyment to distract me."

A nice, charming stroll through a blizzard? I made a note to check on that, although given the thickness of his pelt, it seemed likely Grauw *would* enjoy a snowstorm. He was an alien—which prompted another question. "Are you willing to press charges against the mugger?"

"I believe I shall," he said. "It would give me a chance to see your law system at work."

"Fine." I felt relieved. I didn't know how huxloni thought, and I'd been afraid he would have some alien reason for dropping the whole thing. I called for a clerk, and she took Grauw upstairs

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to file a complaint and make a formal statement.

For a while I sat and stared at the papers on my desk. This whole affair left a bad taste in my mouth; Putnam brought back memories. I'd been a punk like that, thirty years ago: ignorant, loud-mouthed, and a member of the Human Brotherhood. Back then I'd brawled and marched against robofacs and superchimps, but it's all the same, and I don't like to remember what a jerk I'd been.

To be honest, that wasn't the whole truth. Everyone who knew my record knew I'd quit the Brotherhood a few months after I joined it, and that my squadmates had given me a farewell beating. People respected me for that; they thought that I had seen the error of my ways and left the Brotherhood out of a sense of ethics, that they had worked me over because they hated what I now stood for.

Only I knew the truth. I was no martyr. I'd quit because I was sick of paying the dues and fees and tokens—the Brotherhood doesn't quite bleed its members, but it collects a lot of money from them. My ex-squadmates pounded me as a warning to other cheapskates. Morality had nothing to do with the matter.

I felt that I was living under false pretenses.

The phone rang. "Prynne, Tenth," I said.

"Omar? Nettie Goldbaum. What's going on down there?"

There was no need to ask the police commissioner which "what" she meant. "Two hoods tried to mug the huxloni ambassador," I said. "Mr. Grauw killed one of them in self-defense. We have the other in custody."

"Are there any problems?"

I shook my head—pointless, as we didn't have a visual link. "It's an open-and-shut case."

"Are you sure?"

"The perp practically confessed to the mugging. Is there trouble?"

"Yes. There's a news report that Grauw attacked these two kids—that he was out stalking human prey."

So soon? "Ma'am, that sounds like the Brotherhood talking."

"Maybe it is. Can you prove it's a lie?"

I held down a groan. How do you prove intentions? But I knew what she wanted to hear, and there was no point in arguing. "I'll do my best, ma'am."

"Good. Keep me informed. I'm getting a lot of pressure from above." I could see her pulling her lower lip. "The mayor just called me. *He* just had a call from the White House. This is an embarrassing situation, Omar, and it could turn into a disaster. Stay on top of it and don't let anything go wrong."

"I'll take care of it personally," I said, and she hooked off. Embarrassing? Yes. We Americans are their hosts. This attack made us look bad. And it made the NYPD look bad.

Worse yet, this reflected badly on the human race. Right now we've only found one alien race—but we know others are out there, because we've found artifacts and heard radio signals. Some day, perhaps tomorrow, we could find ourselves judged by the way we treat the huxloni.

After a while Muldoon came into my office. "Grauw just went home," she

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said. "He got a ride in an unmarked car. And I sent an extra security detail to the enclave. Four uniformed officers and two plainclothes detectives."

"Good thinking," I said. As if she did any other kind. "How are things outside the enclave?"

She shrugged. "They're about what you'd expect, Lieutenant—reporters and gawkers. So far it's crowded, but quiet."

"Here's hoping it stays that way," I said. I drummed my fingers on the desk. "Sergeant, how would you prove that Grauw wasn't out to kill anyone?"

"I'm not sure I understand."

"The chief just called. She says there are rumors that Grauw was playing vigilante. It looks like some chauvs are trying to poison human-huxloni relations, so we have to prove he's entirely innocent here."

"That's impossible," she said. "No amount of evidence will convince a chauv that Grauw wasn't at fault."

"I know, but we still have to try. Has Crime Scene Squad filed its report yet?"

"A little while ago."

"OK, let's go down to the evidence room and see what we have. Maybe we'll find something." I got up and stepped out from behind my desk—

Grauw's hoofpads must have caught the rug and pulled it up. I tripped over the damned thing and went falling, straight toward a filing cabinet, all corners and sharp metal edges—

Muldoon grabbed me and yanked me aside. I made an undignified but safe landing. "Thanks," I said, picking myself up.

"Any time, Lieutenant." She seemed unperturbed by my clumsiness. Well, I suppose genjees are used to our shortcomings. They're not stronger than us standards, but they do have faster reflexes—and faster thought processes. It had taken her a fraction of a second to see I had tripped, realize I was going to hurt myself, and realize she couldn't stop my fall. Instead she had moved to pull me sideways, making the best possible decision in another fraction of a second.

It wasn't even a remarkable performance. Muldoon had once told me that she had tried skeet shooting when she was ten, but the clay targets were too slow to be challenging.

We went down to the basement and visited the scene of the crime. The mugging had occurred in a part of Central Park called the Ramble, a hilly area thick with trees and bushes. It's a lot like the forest primeval, with the advantage that you're never more than ten minutes from a hot pastrami sandwich. At the moment it was coated with a foot of snow.

The exact spot was near the center of the Ramble, on a curving section of path near a clump of leafless bushes. Crime Scene Squad had made a good hologram of the area, although it was a bit fogged by falling snow. They'd taken the shot within twenty minutes of the incident, so not much had been lost. Muldoon and I sat down in the projection room and let the computer show us around.

Ground Zero was a mess. Waleski lay twisted in the snow, and a flattened patch showed where Putnam had gone down, got up and gone down again. Both men had tramped around before Grauw's arrival, so the snow was pretty churned up, and that's what I noticed. "Look at all those footprints," I told

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Muldoon. "How long would you say they were there?"

"At least an hour, Lieutenant." She nodded, and I knew we were following the same chain of logic: that's a long time to wait in a blizzard. They must have had a good reason. "Someone told them Grauw was coming. They were waiting for him."

"An ambush." I looked at the body. You can't examine a holo the way you can physical evidence, but the computer can make up for that. A few questions told me that Waleski wore a brand-new thermofit under his street clothes, so he'd been ready for a long wait in the snow—and he had a hundred dollars in his pocket. I checked the evidence log, and found that Putnam was equally rich.

Muggers don't go on the prowl when they have that much cash. "Someone hired these two to kill Grauw," I concluded.

Muldoon nodded. "There's no other explanation."

"Right." I spoke to the computer as I left my seat. "Tell the PD we want to talk to Putnam."

The public defender was a young woman, fresh out of law school. She looked resentfully at Muldoon, which I could understand. PD is a dead-end job, but it was probably the best she could get. We standards just can't compete with genjees in the job market. Hell, seniority and civil-service inertia were the only things that kept me in charge of a precinct.

The PD stood between us and the door to the interrogation room. "I shouldn't let you talk to my client," she said. "He's not fully aware of his legal position."

"That's why he has you," I said. She had good reason to be aggressive; a major case like this might push her career out of the doldrums. That wasn't going to make my job easier, unless I could make a little deal with her. "We already have enough evidence to convict your boy. The thing is, we think someone hired him to assassinate the ambassador. If that's the case we need to know who it was."

"I see." The PD's thoughts showed on her face. If Putnam was just a henchman, and if she got him to cooperate, she could try to get him a reduced sentence. If not, it wouldn't hurt her career if she looked cooperative.

We went into the room. Putnam was sitting at the table, making paper airplanes out of some note paper. The PD told him he didn't have to talk, but that answering our questions might help him, and so on and so forth. The cocky little bastard just smiled as she finished. "I got nothin' to say," he told us.

"We think you do," Muldoon said. "Somebody told you where and when to find Grauw. The same somebody paid you to jump him. We want you to name the somebody."

Putnam snickered. "I bet you do."

"We'll get the name sooner or later," I said. "Now, if you can make it sooner instead of later, the DA might keep that in mind when he takes you to court."

"Hey, this is my first offense," Putnam said casually. "What can he do to me?"

"Plenty," I said. "Putnam, attacking an alien is a federal offense. That's twenty years in Leavenworth right there. Add homicide and you're looking at a life sentence, maybe longer. Your only

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hope is to convince some judge that you've seen the error of your ways." Once upon a time I could have taken the easy way out, and let him turn state's evidence. Then he would have told me everything I wanted to know—but it would have given him immunity from prosecution. That's why the concept of state's evidence was outlawed while I was still a rookie. Too many hoods were getting off, and in the long run that didn't make life easier for anyone, citizen or cop.

Putnam wasn't making things easy now. "What error?" He leaned forward and spoke as if he was explaining things to an idiot. "Thinking some animal matters, that's an error. Selling out my buddies, that's an error. Getting the wrong people mad at me, that's an error. You see?"

"I suppose I do." I stood up and looked at the PD. "Good luck, counselor—with your client, you'll need it."

"Somebody big hired him," Muldoon said, once we were out of the room.

"Yeah, it shows," I said. The punk had seemed more impressed by his employer than by the threat of jail. "My bet is that if we do a little digging we'll find he belongs to the Brotherhood."

"I don't know," she said. "I can't see anyone using Putnam and Waleski as assassins. They're too inept. It's almost as if they were hired to fail."

She had a point. "Maybe their boss has never used hired killers before," I suggested.

"In which case they definitely *weren't* hired by the Brotherhood."

I sighed. "All we're saying is that we don't know enough. So let's start digging."

Digging. We got computer runs on Waleski and Putnam. Neither of them had criminal records, which only proved they'd never got caught at anything. They were grade-school dropouts, unemployed, and rooming in a welfare hotel in a bad section of Flatbush.

Looking for a rotten way to waste an afternoon? Go to a welfare hotel, announce that you're a cop, and ask questions. The Trump Freehold was one of those minimum-bid places the city built around the turn of the century, using concrete slabs and allegedly vandalproof utilities. It had a hundred apartments, all crowded and none livable —plumbing backed up, light panels layered with graffiti, repairbots either broken or stolen.

The boarders seemed as indifferent to the decay as they did to Muldoon and myself. We showed pictures of Putnam and Waleski to over two hundred people, and no one admitted knowing them or ever having seen them. They may even have been telling the truth; the sort of people who end up in Trump don't have friends.

Putnam and Waleski had shared a one-room flat. It was what you'd expect: a couple of old mattresses on the floor, trash heaped in the corners, a vidplayer and some porno discs.

Muldoon found some more discs in the kitchen cabinet. "They *were* in the Brotherhood," she said, looking puzzled. She read the labels: " 'The Duties of Humans.' 'Human Glory.' 'How to Fight.' "

I took the discs from her, looked them over and dumped them in an evidence

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bag. They had the Brotherhood logo on them, with membership numbers scrawled on the labels. Now we could link our muggers to the Brotherhood.

Nothing else turned up in our search, and we left the apartment. "This is all futile," Muldoon said as we got into our car. "Tomorrow morning Chief Goldbaum is going to call us in and tell us that the FBI has taken over the case."

"Yeah, I know," I said tiredly. The Feds wouldn't leave a thing like this in local hands. Bringing in the FBI would show the huxloni, and the rest of humanity, just how seriously Washington viewed the situation. "But right now we're on the case, and we act like we're staying."

"OK. What's our next step?"

I held up the evidence bag. "We get a warrant and examine the Brotherhood's records. I doubt we'll turn anything, but that'll put some pressure on them."

Muldoon looked skeptical. "What good will that do?"

"Maybe none, but with any luck we'll get a response. Maybe we'll make someone antsy enough to slip." I started the car and we pulled away from the curb. "And we'll have another talk with Putnam, first thing tomorrow morning."

We went back to the Tenth, and I tried to get a warrant for the Brotherhood's files. I struck out. Judge DeWitt pointed out that all I had was circumstantial evidence and suspicions. "Come back with something solid," she told me.

"I'll have something tomorrow," I promised, and hung up. I'd halfway expected to get turned down, so I wasn't too disappointed. The one thing I had counted on was a leak in the line. There are cops and clerks who belong to the Brotherhood, and one of them was bound to get word of my interests to his or her boss. That should stir things up.

It was late. I signed out and took the subway home to Flushing. The rush hour was over, so I found a seat. I unfolded my news sheet and keyed it for info about the mugging.

There was plenty of that, most of it wrong. Grauw had been attacked by one, two, or three killers; one, two, or three innocent kids had been jumped by a crazed alien. There had been several deaths and a riot had broken out, and it was all based on eyewitness accounts.

Eyewitnesses who had left no footprints at the scene of the crime. I discounted all that at once, but I did find one strange thing: the Human Brotherhood had nothing to say. Oh, a junior centurion of the New York legion made a brief statement about the utter evil of everything non-human, but he said nothing about the mugging itself. None of the real leaders made any comment at all.

That puzzled me. I could think of a dozen cases where they'd blown their mouths off without having any facts. Forbearance has never been the Brotherhood's style.

I got off the subway, bought some take-out at a Nepalese diner and went to my apartment. I've lived alone since my divorce, and there are times when that has advantages. This was one of them. I was able to flop down in front of the cube and eat while I flipped around the dial. I wasn't looking for

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anything in particular; I was trying to gain a general impression.

My vid line carries over two hundred channels. I concentrated on the ones that had suspended their regular services for coverage of the mugging. There were a score of those. Some of them were local channels, while the others were national and international.

None of them said much about the crime itself, aside from noting the number of conflicting reports. Some stations played a recording of a statement Goldbaum had made, which only said that the NYPD could make no comment about an ongoing investigation. There were shots of Grauw being escorted into the huxloni enclave, and a huxloni named Czhal expressed her belief that this incident was an aberration, one that would have no lasting effect on interspecies relations.

I hoped she was right, but it looked like the incident had unleashed something ugly among us humans. A New Jersey station had flanged together a documentary on huxloni fighting prowess, "proving" they were a menace. The program said it was a matter of evolution. Huxlon was populated with a variety of dangerous predators, and the gentlest of them was comparable to the terrestrial wolf. The huxloni had survived by evolving greater speed and intelligence—their average IQ stood at 150—and it was claimed that that made the huxloni superlative fighters.

Compared to us? Maybe. We humans have used technology to subdue our natural enemies. The huxloni have existed as civilized beings for over two million years, but their technology never advanced beyond the neolithic stage. There are no accessible metal ores in Huxlon's crust—just traces of the elements needed for life. The lack of metals has kept the huxloni from developing more than a rudimentary science and technology.

That's left them in a stalemate with their native predators. One channel showed a tape which the *Endeavor*'s crew made soon after they found the huxloni. A vrakh had jumped over a town wall and charged toward the photographer. Before she could draw her stunner a huxloni charged out of a building, pulled off a hoofpad, and gave the beast a flying kick which cracked its skull. Even in slow motion the action was blurred.

After I saw that I scrawled a note to myself. Grauw had kept his hoofpads on. If he'd been serious about killing anyone, he could have removed them in an instant.

Then I scratched the note. Some idiot could argue that Grauw had decided to kill Waleski with his bare hands. No, I was going to have to prove that Grauw had been acting in pure self-defense.

I flipped the dial some more, and found a panel discussion. I couldn't follow their arguments—too much shouting and name-calling—but it seemed some of them thought that the huxloni were basically incompatible with humans. The logic involved the polyandrous nature of huxloni society. A female's status is marked by the number of her husbands—and something else. The huxloni reproductive system is a use-it-or-lose-it proposition; if a female doesn't become pregnant every time she's fertile, she goes through a form of menopause and becomes an asexual drone, and a virtual slave.

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The learned gentlefolk of the panel almost came to blows over what that implied. Was polyandry an instinctive thing with the huxloni, or was it a social adaptation to prevent population explosions? Were drones necessary to the functioning of huxloni culture? Did the males compete for the more desirable females, or were the females the ones who dragged the males into a polyandry?

None of these great minds suggested that they call the huxloni enclave and ask for answers. I whistled for the maidbot to clean up after me, clicked off the cube and went to bed.

But not to sleep. The memories always come back when I have to face something out of my past, and they're always as close as the empty side of my bed.

A generation ago I'd been a rookie cop, just married, and faced with a new decision. Have children, yes, but should they be gengineered? Sylvia had liked the idea of giving our kids that edge. I hadn't agreed. I'd figured that gengineering was just a fad, that when the kids grew up they'd hate us for making them freaks . . . and how would we feel, having changelings for children? Eventually Sylvia had agreed.

Now our children hated us for handicapping them with merely normal minds. Neither of them had talked to us in years. Sylvia had divorced me over that, blaming me for a decision we had both made, saying that at heart I was still a Brotherhood trooper, afraid of change and unable to change. I had no way to prove she was wrong, not even to myself.

I forced myself to think about the Grauw case, just to clear my mind. I was finally dozing off when another oddity struck me. The mugging had gone down in my precinct, Putnam was being held at the Tenth, and I had not seen one reporter all day.

"Yeah, we had some reporters here yesterday," Sergeant Ling told me, when I came in to work the next morning. He checked his desk recorder. "While you were in Flatbush. They asked a few questions and left."

"Funny," I said. "You'd figure they'd be on us like flies."

Ling shrugged. "Putnam is no prize, Lieutenant. Once they figured out he was just another punk, and not somebody's sweet baby boy. . . ." He shrugged again.

"Yeah," I said. Hoods make lousy video. "Is Muldoon in yet?"

"I think she's in Research. Lieutenant?" Ling looked as if he was about to have his teeth pulled. "Putnam has a lawyer—Richard Michael Glenfield. He's here now."

I groaned and wished I'd taken early retirement last year. Glenfield is the latest in a long line of silk-scarf shysters, a lawyer who'll take any case that stinks of money or notoriety. He specializes in delaying tactics, dragging out cases until his opponents get tired and settle out of court. The ABA would love to disbar him, but he's never quite crossed the ethics line.

I paged Muldoon, and we went to see Putnam. I'd had hopes that a night in jail would make Putnam more reasonable. A holding cell isn't a fun place to spend a night. The toilet's out in the open, the bunks have no sheets, and the

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five-hundred watt light in the ceiling never goes out. We'd kept Putnam isolated, just to make sure nothing happened to him, but beyond that he'd had a good preview of his next few decades.

Glenfield met us outside the interrogation room. "I've advised Mr. Putnam not to say anything," he said. He adjusted his wavy gray hair in a careful show of disdain for us. "Let's not waste my time, officers, by making me sit there while my client stands mute for hours on end."

"Since when is he your client?" I asked.

"The Human Brotherhood has retained my services," Glenfield said. "They won't have an innocent man turned into a scapegoat. I'm not going to let you badger my client into saying anything that might possibly be misconstrued."

"Now would we do that?" Muldoon asked, her voice catty. "With a fine lawyer such as yourself watching our every move? And we *will* see him now."

Glenfield glowered at her, but he had to back down. We went into the room, Muldoon and I sitting on one side of a scratched plastic table, Glenfield and Putnam on the other side. As Glenfield eased his bulk into the seat Putnam shrank away from him.

I watched Putnam while Muldoon did the talking. She told him the obvious: that he'd been hired to kill Grauw, that we had enough evidence to convict him of quite a few things, that he faced a long prison stretch, that if he had any sense he'd cooperate and hope the judge took that into consideration.

Putnam stared at the tabletop during her spiel. He looked withdrawn, and I wasn't sure he was listening. His eyes fascinated me. I've seen smart-asses who've been sobered by a night in jail, but the fear in his eyes was deeper. I was reminded of my first hostage situation; the hostage had had that same look in her eyes.

Putnam shook his head when Muldoon had finished. "I got nothin' to say," he mumbled.

"There you have it." Glenfield was smirking. "My client knows he can't improve his position by helping you. If you persist in harassing my client, I'll be forced to complain to the Police Review Board."

"Complain away," I said, rising from my chair. "Personally, I think your client is too stupid to be of any use." Do I usually insult perps? Yes, when I don't want them thinking they're in charge of the situation. I wanted Putnam to know I was leaving because I was through with him. And I was, for now; he was scheduled to be transferred to Riker's Island pending his trial.

Glenfield was threatening to file a complaint of verbal abuse as Muldoon and I left the room. "Someone has been clumsy," I said.

"I don't follow you, Lieutenant," Muldoon said.

I squelched a smile. Muldoon's a genius, and a sergeant, but she's still only twenty-two. She hasn't had the time to gain my experience, and it felt good to know I was one up on her. "You saw how Putnam looked. Glenfield threatened him."

"To keep him from talking. I see." She spoke as we went downstairs and entered my office. "So whoever hired

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Putnam also hired Glenfield, and told him to keep Putnam quiet."

I nodded. "Our 'whoever' must be someone big. Someone who'll do anything to avoid being linked to this. But he shouldn't have used Glenfield to threaten Putnam. He should have had someone else do that."

"It may have been the only way to get the message to Putnam," she said, and smiled. "That's bad planning, isn't it?"

"All the way through." I sat down at my desk. It was just after nine, but already I felt tired. "Things just don't add up."

"Then we don't have enough things for addition," Muldoon said. "Now—"

The phone rang. It was Goldbaum, and she wanted to see me at once.

Goldbaum had a penthouse office in the La Guardia Building, a structure too short to give a decent view of the city skyline. That didn't matter now, as she had the curtains drawn and the polarizers on. "I don't think I'm under surveillance," she said, "But Mr. McAdoo thought it best to avoid taking chances."

I hadn't noticed the man sitting at the side of her desk, but once I saw him it was impossible not to recognize the president's chief of staff. Alphonse McAdoo was a short, waspish man with white hair and a driven look on his face. He remained seated as Goldbaum introduced us. "How are you coming on the Grauw case?"

"We're finding things," I said, and I told him what we had so far.

"An assassination," he said when I'd finished. "We had hoped this was just a random crime. Do you have any suspects?"

I had to shake my head. "Not yet. The Brotherhood is our prime suspect, but that's all circumstantial. The mugging seems to've caught them off-guard, and they may just be exploiting Putnam for the publicity."

McAdoo nodded curtly. "That would explain Glenfield's presence. Win or lose, he'll draw attention. But you're certain he intimidated this Putnam?"

"I'm certain," I said. "The trouble is I have no evidence. He *could* be working for two parties; the Brotherhood might not know he was paid to threaten Putnam."

"But you doubt that."

"It's too complicated."

"I agree. Well, Commissioner Goldbaum puts great stock in your judgment." He nodded once, decisively. "I agree with that, too. Are you familiar with section six of the Huxloni Treaty?"

"No, sir." I had a vague recollection of the Senate debate, some time ago, when the treaty was ratified. I hadn't understood the fuss, but then again, I'd been too wrapped up in a case to pay much mind.

"Section six allows for the suspension of the Fourth and Fifth Amendments in all criminal cases involving aliens." McAdoo looked sour. "We had a hell of a row when we shoved that through the Senate, but the president thought it was vital. He was afraid of an incident like this—and of the consequences if the guilty parties escaped on technicalities. Imagine a superior race holding us accountable some day, and be glad he was stubborn."

McAdoo picked up his briefcase and

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opened it. He took out an envelope and held it out to me. "This is a treaty writ, Lieutenant Prynne. It authorizes you to collect evidence and detain witnesses, as you see fit. It's a blank check."

"Sir?" I wasn't sitting; Goldbaum had me standing on the Persian carpet in front of her desk. I wished I was sitting, because I suddenly felt strange. Not dizzy, not ill, but strange. "I don't understand. Isn't the FBI taking this case?"

"No." McAdoo fingered the long white envelope. "They should, but Ambassador Grauw has asked that this be handled as a routine police matter. He wants to see how we handle criminal investigations. You'll keep him informed and answer his questions. You'll need this writ to expedite matters."

My mouth felt dry. "A blank check isn't a usual part of our routine."

"I know," McAdoo said. "We've explained to Grauw that it's politically impossible for us to treat this as a routine matter. We told him you would be granted extra investigatory powers. Fortunately he accepts the necessity."

"I see." I ran a hand through what's left of my hair. The powers in the writ tempted me, but I've never felt more reluctant about anything in my life. "Is this necessary, sir? The writ may be legal, but there'll be an uproar if—"

"Possibly," McAdoo said. "That's not your concern, although I expect you to use this with discretion." He held out the writ again, and looked impatient when I hesitated. "I understand you once belonged to the Human Brotherhood. If you have qualms—"

I almost snatched the envelope from him. "I can do my job," I told him. I felt surly as the devil; I don't like being goaded.

"Good." McAdoo said. He stood and picked up his briefcase. "There's one more thing, Lieutenant, although it's more in the nature of a favor than an order."

"Sir?"

"Can you find out why Grauw wants this treated as an ordinary crime?" McAdoo held up his free hand. "Not to reflect on your abilities, Lieutenant, but his request isn't in his best interests. The president would like to understand his motives; that knowledge could make our dealings with the huxloni easier."

"I'm not offended, sir." Grauw *would* be better served by the FBI (and I was willing to bet that they were running their own, independent investigation). I could see that, and if my feelings had been hurt, being asked to do a favor for the president soothed them.

I drove back to the Tenth, with that damnable writ burning a hole in my vest pocket. Once I was safe in my office I opened the envelope, read the writ, read the accompanying papers which delineated my new powers. Then I called in Muldoon. "We're still on the Grauw case," I told her, and handed her the papers. "Grauw wants this handled as an ordinary criminal case, and the Feds are obliging him," I told her about my meeting.

"Interesting," she said. She flashed through the papers and handed them back. "We can use this. I think our best approach is to check the Brotherhood's financial records."

"That won't do any good," I told her. "Putnam and Waleski were paid cash. It could be laundered a dozen

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ways, even if we assume that the Brotherhood hired them."

"I know," she said. "But I'm more interested in how they're paying Glenfield. He's expensive. Using him to deliver threats would only raise his price."

"The Brotherhood has always been a money-making proposition," I reminded her.

"It always *was*," she corrected me. "But its membership has been dropping for the past twenty years. It's below a hundred thousand now—"

"Really?" I'd always thought the Brotherhood had several million members, as it had when I'd belonged. God knows the news media gave the impression that it had an enormous membership. But now that I thought of it, their demonstrations outside the huxloni enclave had always been small, and their brawls had never grown into full-scale riots.

"I was surprised, too, Lieutenant." Muldoon came around my desk and switched on my terminal. "But I did some digging this morning. The figures are obscure, but it's impossible to miss the shrinkage." She keyed in her findings.

I stared at the screen in bemusement. With her usual thoroughness Muldoon had sifted through the sources, found the reliable ones and tied them together. The Brotherhood's income had dropped even faster than its enrollments suggested; they'd cut their fees and charges in an effort to hold on to members.

Maybe I shouldn't have been surprised. Two or three decades ago the Brotherhood had had real enemies to fight. There were automated factories, gengineered superchimps and robots, all of which caused unemployment among blue-collar and unskilled workers—the sort of people who joined the Brotherhood. The modernization of industry had caused upheavals, but things had settled down over the past decade. Unemployment now stood at one percent, and that deprived the Brotherhood of potential recruits.

"I don't know, Sergeant," I said at last. "They obviously scraped up the money for Glenfield."

"But how, sir?" She smiled. "I think someone hired the Brotherhood to kill Grauw, to cause a diplomatic incident. The hit went bad, and now the Brotherhood and their contractor are trying to cover their anatomies. The contractor is paying Glenfield's tab. Going through the records will put us on the contractor's trail."

I sighed. "Possibly . . . but we'll never convince a judge to let us take the Brotherhood's records, not on the strength of this." I tapped the screen.

Muldoon frowned. "You have the treaty writ."

"We won't use it unless I think it's necessary," I said. I'd laid the writ on my desk; now I tucked it back into my vest pocket. "I know the Brotherhood, Sergeant. They thrive on persecution. The last thing I want to do is hand them an issue."

"So we just ignore them?" She looked disgusted.

"Did I say that? We'll get a normal subpoena for the records on Putnam and Waleski. The Brotherhood will scream, but no one will listen."

"Can we do anything with just those records?" Muldoon asked.

"It depends on what's in them. They

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may open the way to something bigger." I smiled tightly. "At least we'll put pressure on the Brotherhood."

I called Judge DeWitt, and persuaded her to issue a subpoena for certain records relating to the Grauw case—written records, of course. It's too easy to fudge computer documents, which is why the law requires hard copies of everything. I didn't have anything "solid," as she'd demanded the day before, but Glenfield's presence was enough to tip the scales of justice.

Or was that all of it? I recalled that she had two children, both of whom were enhanced. That might have helped persuade her.

Muldoon and I drove down to the Civic Center and picked up the subpoena. After that we headed for the Brotherhood's regional offices in the Upper West Side. The place was on Broadway, and I know that sounds like a prestigious address to anyone who doesn't know New York. However, this area was several blocks away from the good neighborhoods. The offices were in a rebuilt apartment complex, set between a rescue mission and a transients' hotel.

We parked in front of the offices. As we entered the lobby I noticed a dozen people there, lined up in front of a card table. New recruits, shabby, sorry sons of bitches, not much different from what I'd been thirty years ago. The man behind the table wrote down their names, gave them video discs and ID cards, and congratulated them on becoming Adepts of the Human Brotherhood.

The kids looked solemn as they handed over their initiation fees. Uneducated, unemployed and probably unemployable, they were buying the only self-respect they could find.

I remembered how I'd felt after my own initiation rites. I was no longer some poor schlep on welfare; I was part of something bigger than myself, something that would force the world to respect me. That same something was going to make the world stop throwing humans like me in the ash can—no more robofacs and jazzed-up chimps to take away our jobs. I had felt like I was finally in control of my life.

I could see that these kids felt the same way. And they were as wrong as I'd been.

The lobby of the building wasn't quite seedy, but it was falling toward that state. Muldoon and I walked upstairs—the elevator was out of order, its door stuck half-open—to the offices. Most of them were empty.

The largest office was not empty. There were a half-dozen men and women in it, all dressed in the Brotherhood's quasi-uniform—black pants or skirts, tan shirts, black berets. Uniforms give their wearers a sense of identity . . . and it's a human weakness to defer to someone in a uniform, to give them a moral authority they may not have earned. Whatever else they were, the people who had organized the Brotherhood were not fools.

For a paramilitary group they had a lousy security arrangement. They were surprised to see us enter their office. "Who are you people?" a woman demanded.

We flashed our badges. "Lieutenant Prynne, Sergeant Muldoon, NYPD," I said. "Who's in charge here?"

"I am." The man behind the small

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oak desk stood up. He was a beefy, thirtyish man. His uniform had a tailored look; the lapels and cuffs showed a silk lining, and the cufflinks were amethysts set in raw gold. "Centurion Warner of the Fourth Legion." He wasn't going to stand, not for cops. Warner was a hood, pure and simple; he'd done time in Attica, once for burglary, once for kiting checks. He was also a member of the Brotherhood's Command Staff, and a contender for its top position. Combine those facts and you had a man who had no use for cops.

I handed Warner some papers. "These are your copies of subpoenas for all records relating to two of your members, Fredrick Waleski and Joseph Edward Putnam."

Warner didn't even look at them. "The men you named aren't members of the Brotherhood."

Ah? I pulled out my note pad. "We also want your records on two members, serial numbers L4-45039 and L4-31058." Those had been the numbers on the discs in Putnam's apartment.

Warner shook his head. "We don't have any members with those serial numbers."

"You seem certain of that," Muldoon said.

Warner smiled a bit. "We don't use that numerical sequence. *You* should know that, Prynne."

So he knew that I'd been in the Brotherhood—well, it had never been a secret. "I don't know any such thing," I told him. "Warner, why don't we have a private talk while your staff digs up the records?"

"Why, whatever you say, officer. Always happy to cooperate." He made a curt gesture and his staff left the office. As the door closed behind them he settled down behind his desk, opened a drawer and pulled out a crystal brandy flagon and matching snifter. He spoke as he poured himself a drink. "It's going to take them some time to check the records and prove we don't have what you want. Will you arrest me when I disappoint you?"

"That all depends," I said.

"I won't even fight if you do." Warner leaned back, rested his feet on his desk and sipped his brandy. He wore boots, I noted, of hand-tooled Moroccan leather. "We can use the publicity. Of course, this thing with the beast is already a help—it hasn't been a day since the monster offed that guy, and our enlistments are already upswinging."

"Along with your revenues," I said.

"Defending the human race takes money," Warner said placidly. "Normal people like you and me and the lady—" he toasted Muldoon with his snifter "—need to look out for our rights. Lawyers, lobbyists, publicists—they all cost."

"I don't see the huxloni as a threat to my rights," Muldoon said. She was looking around the office, quietly assessing it. There was nothing to see, however, beyond the trappings of vulgarity.

"No?" Warner didn't quite sneer at her. "Well, a lot of people don't. Why should they? All they ever see are the faggoty males and the artsy-craftsy trash they sell to museums. They don't see the calculating brains behind those fuzzy muzzles."

Booze and a big ego always add up to talk. I didn't expect Warner to spill

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anything useful, but I wanted to keep him talking, just in case. "So what makes them a threat?" I asked.

"Human weakness." He finished the drink and put the snifter down. "We get caught up by fads. Let something new come along and we imitate it. A few years from now you'll see idiots forming polyandries like these animals. There'll be three and four and five simpering men hooked up with one overwrought lady. Some girls won't be able to catch husbands, and when it comes to sex they'll either do without or turn to one another. Maybe that's OK for aliens, but it'll kill humanity."

"I wouldn't want more than one husband," Muldoon said. She had picked up my lead—or she may have wanted to hear what Warner had to say. There must be a certain morbid fascination in talking with a man who—strictly as a matter of principle—wants to kill you. "Just having two boyfriends at a time is hard enough."

"Then you're more levelheaded than most people," Warner said. "But with most people it's 'monkey see, monkey do.' We see something new and we just have to try it. People have no damned sense."

"Aren't you exaggerating?" Muldoon asked. "We've known about the huxloni for several years, and no one's acted that way."

Warner gave her a knowing smile. "Then you *don't* know what the government has in mind. They're preparing legislation which will force the genetic engineering of all children at conception. Why? Because they don't think normal people are as good as these aliens. We have to have brains like theirs. Washington says, cold, inhuman brains.

"You can guess what that means for us real people," he went on. "Our children will have to compete against these freaks for jobs. It's already bad enough." How many times have you two been beaten out of a promotion by some genjee?"

"That's not something I worry about," Muldoon said. "I *know* I'm the best."

"Really?" Warner asked. "Not many people have your confidence. They feel outclassed by these monstrosities. Employers will hire an unqualified genjee over an experienced human any day, because the freak is supposed to be superior. We're losing our power over—" Someone rapped at the office door. "Enter."

A birdlike, middle-aged woman came in. "We've checked our files, Centurion. There's no record of a Putnam or Waleski, and there's no serial numbers like they said."

"Too bad," I said. "I guess we'll have to call in a Special Investigations team. Let's go, Sergeant." I started to stand.

"Now, wait," Warner said at once. "Phyllis only meant there's no record *here*. We send our records to our headquarters in Idaho. For safekeeping."

"All right." I hoped I sounded properly reluctant. "You have two days to produce those records. If you don't, we'll bring in the Feds."

We were back in the car before either of us spoke. "And they say racism is dead," Muldoon said, her voice flat.

"Nothing dies while it can still turn a profit," I said. I felt a bit guilty over exposing her to that ugliness, but it's

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part of the job. "Hate-mongering is a good business. It always has been."

"That's not what I meant, Lieutenant." She looked wry. "I'm black, so Warner can't imagine me being enhanced. I suppose blacks can't possibly have those superior brains he's afraid of."

"Maybe." That's the thing about racism; when you hate one group, you generally hate a lot of other groups . . . and you underestimate them all.

I started the car. "We did a lot better than I hoped," I said, as we pulled away from the curb. "In a few more days, Sergeant, we and the Feds will have all the Brotherhood's records."

"We need them now, sir."

"There's no hurry." I patted my vest pocket. "You think I should have whipped out the magic paper, don't you? That would have let us dig through their files, and maybe take one or two little things. Instead I got Warner to panic. He says the records are in Idaho, right?"

"He's lying," Muldoon said. "He's just using the law to buy time. Two days from now he'll hand us a set of doctored books."

I nodded. "And he'll say they were shipped in from Idaho. That's across state lines, so when forensics finds that the records have been altered—"

"We'll have him on a federal offense." Her face lit up. "And *that* will give us access to all of the Brotherhood's records." Then she shook her head. "But the treaty writ would let us do the same thing, Lieutenant."

I shook my head. "It would only give us stuff related to the case, not the whole schmeer."

She sighed. "It would still save time."

"Maybe," I said, "But this way they won't have a reason to squawk about having their rights trampled. If nothing else, Muldoon, I won't give them that satisfaction." I chewed my lip as we pulled through the Manhattan traffic. "Right now I wish I knew what it is about Putnam and Waleski's records that upset him. Somehow I don't think anyone was dumb enough to write down a payment for an attempted killing."

"I doubt he cares much about them," Muldoon said. "It's more likely that the records tell too much about the Brotherhood's finances—probably how much money the leaders skim off."

"I agree." It was obvious that little of the Brotherhood's income went to paying for its operations. A scan of the books would prove that leaders like Warner were siphoning funds. It's a funny thing about crooks: they never have enough money. Put them on a salary, give them bonuses, throw in all the perks you can, and they'll still try to grab more.

"We could use this against them," Muldoon said, half to herself.

I nodded. "We'll be able to nail some of the leadership on embezzlement charges. It won't kill the Brotherhood, but it'll slow them down."

"I wasn't thinking of that, Lieutenant." She looked pleased. "How will the average member feel, when he realizes that his leaders have been swindling them?"

I forced myself not to laugh at her. "Sergeant, most of them already know about it. At least, they did when I belonged." I verged on telling her the

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truth about my defection, but then I decided it would make life too complicated for both of us. "The troops don't resent it; they admire the leaders for getting rich. And it gives them an incentive to get promoted."

"So they can get a share of the loot?"

"It's human nature, Sergeant."

"Yes." Muldoon was frowning. "Well, there's another oddity, Lieutenant. The Brotherhood's initiation fee is fifty dollars. The papers on Warner's desk say that they collect that much from the enlistees. But those kids at the recruiting table were only paying out twenty-five bucks. I could swear to that in court."

"You may have to," I said. It made no damned sense, but any discrepancy in an account book is cause enough for legal action, and we could use that.

Our next stop was the huxloni enclave. McAdoo wanted me to keep Grauw informed, and I was going to do that by giving the ambassador a firsthand look at a police investigation. He was our prime witness, and I had questions for him.

The enclave was a renovated brownstone a few blocks north of the United Nations Plaza. As I had expected, there was a crowd of reporters in front of it, with a variety of cameras and snoopers focused on the building. We drove into the alley behind the enclave. The rear entrance was watched by four cops and a pair of reporters. I ignored the reporters, showed my ID to the senior officer on duty, and went in the back door.

The door opened into a small atrium with an inner security door and an intercom station. A huxloni face appeared on the screen—a female, to judge by the shape of her chin and ears. "May I help you?" she asked.

"Lieutenant Prynne, Sergeant Muldoon." We held our badges up for the camera. "We'd like to see Ambassador Grauw."

"A moment, if you would." The image turned aside and said something in huxloni. Then she looked back to us. "You may enter. Mrs. Hronk will receive you." Her image flicked off and the door rolled away.

"I wish I knew more about them," I muttered. I wondered if the huxloni we'd spoken with was a drone. Probably—and that thought made me uncomfortable. "Who's Mrs. Hronk? Grauw's wife?"

"Probably," Muldoon said quietly. "She's also an artist. Some of her work is on exhibit at the Guggenheim. It's—fantastic."

I'd heard about it, but I'd never seen it. Who has the time? But I did know that art sales were the enclave's main source of income, and I'd heard that they had fetched along a prominent artist for that purpose. The huxloni had refused to accept loans, grants or credit from the human race. They seemed intent on paying their own way, and by appearance they were doing it in style.

The first thing I noticed when I went through the security door was the air. It was cold, about forty-five degrees. My breath steamed and I was glad I'd dressed for winter. Muldoon had started to shuck her coat; she buttoned up again.

We were in a short hallway, lined with doors. A huxloni stepped out of one, and I decided she was the one I'd

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spoken with. "I am Khlos," she said. "Please follow me."

Khlos led us up three flights of stairs to an artist's studio. We were a few paces from the door when a young huxloni hopped into the open. She—a guess—was about as big as a human two-year-old, and she wore one of those message shirts that tourists buy, instead of the usual huxloni belt pouch. The kid rattled something at Khlos, then bounded down the hall.

There was an adult huxloni in the studio, working with sculptor's tools at a bench. Khlos said something to her, and the sculptress snapped something back. Maybe it's a mistake to read human etiquette into alien behavior, but I couldn't help thinking of a society matron dealing with a parlor maid. If Khlos was a drone, she clearly lacked any status.

Khlos turned to us. "This is Mrs. Hronk. Introduce yourselves, please."

We did so as Khlos left. "Grauw see, you wish," Hronk said, putting down her tools.

It took me a moment to realize she was asking a question—she had not inflected her words, and her English was not the best. "Yes, we need to ask him a few questions about the incident," I said.

"In-ci-dent means, you tell."

"The mugging," I said. "The attack."

"The attack, I know." She pulled a small stool from under the bench and perched herself on it. "Humans attackers, you find."

"We have one attacker in jail," Muldoon said. "We are still looking for some people who helped him."

Hronk looked at her for a moment. "Number husbands, you have."

"I'm still single," Muldoon said.

Hronk turned to face me, ostentatiously ignoring Muldoon. Point taken: Hronk was a snob. Human or huxloni, she would not treat a single female as her equal. Her bad English may have been another sign of snobbery, a refusal to learn the alien language. "Humans attackers, you find," she repeated.

I repeated what Muldoon had said. "We think we will find them soon," I added.

"Find soon, that maybe. Come here, I find." Hronk's arm became a brief blur of motion. She picked up a tool from the bench and threw it, and it went *thwok!* into the studio wall.

I went to it, pulled it out of the wall and looked at it. It was a ceramic throwing knife, and whatever technique Hronk had used to harden the clay was excellent, because the knife had kept its point. The wall had scores of knife-holes in it, all close together. Hronk had been practicing, and she was good.

As I returned the knife to Hronk I noted the sculpting tools on the bench. They came in symmetrical pairs, designed to fit the left or right huxloni hands. Most of them were elegant, flowing shapes, made from wood, bone or clay. A few had an awkward look—huxloni handles fitted to soldering irons, screwdriver blades and other human implements.

Hronk noticed my gaze. She picked up a left-handed screwdriver and held it out to me. "Bad art, not pleasing," she said. "Human metal, huxloni clay. Poor fit, ugly shaping. Bad bond, bad life."

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I took it and looked it over. I haven't handled tools since a high school shop class, but I could see why she was displeased with her handicraft. The balance was bad and it didn't look like the clay held the metal firmly. Just the same, the huxloni must have needed tools like this to repair the doohickeys the enclave bought for itself.

Grauw walked into the studio and greeted us. He said something in huxloni to Hronk, then turned to me. "We may talk more comfortably in my office. If you would accompany me?"

Grauw's office was on the first floor. It was small, but comfortable, with seats for both humans and huxloni. The desk was equipped with an IBM translator, and the stacks of printout—along with the heaps of books, magazines, and other documents—said that Grauw made frequent use of it. There was a counter-surveillance unit mounted on a wall, the sort that most embassies use to block eavesdroppers. That was in addition to the security measures provided by our government.

"I did not expect to see you so soon," Grauw said as we took our seats. "Does this mean that your investigation is succeeding?"

"We're really here to ask you some questions," I said. "We're convinced that Putnam and Waleski knew when and where to find you. Is there anyone who knows your schedule?"

He nodded. "Yes, everyone in the enclave knows it."

"Do any humans know?" Muldoon asked.

"I cannot say. None asked me, but this proves nothing. As I did say before, I walk through Central Park often. The seminar at Columbia received some publicity, so anyone who did know of it could deduce my movements."

"That doesn't follow," Muldoon said. "There are any number of paths through the Ramble—it's called that because the paths ramble through it—yet Putnam and Waleski knew exactly where to wait for you."

Grauw blinked rapidly. "Yes—of course. Humans prefer hot weather, thus those two did go out in unpleasant conditions. I did think it only a coincidence that they were at a spot I favor."

Ah-ha, I thought. "Does anyone know this is a favorite spot?"

"Again, I did tell only members of the enclave. I mentioned that I planned to stop there on my way to Columbia." I think he looked thoughtful. "Yet my movements are no secret. Could they have been observed, or even predicted?"

"Possibly," Muldoon said. "How often do you go to this spot?"

"Perhaps two times a grha—excuse me. About once a local month. I fear that over-familiarity would spoil the charm of the place."

Muldoon shook her head. "Once a month isn't often enough to make a reliable prediction, even with a good computer."

"I see. I will ask if any discussed my plans with human acquaintances. Perhaps you can follow a trail of words."

"That's police work," I said. "Which reminds me, I've been asked to keep you informed on our progress."

"I appreciate that, as I have many questions. But this requires time, and you must hunger." He got up, went to the door and said something—a name.

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I suppose. A huxloni female came to the door, talked with him briefly and left.

"Our kitchen is well-stocked for human guests," Grauw said, returning to his seat. "And, as local restaurant law requires, all meals are untouched by human hands."

I had a feeling he got a lot of mileage out of that joke, but Muldoon and I laughed anyway. While we waited for the food to come up, I told him about our examination of the crime scene, and how too many footprints had told us this was more than a simple mugging. "I take it you don't have much crime back home," I said, after I'd answered a few simple questions.

"No, my world is placid," Grauw said. "But I anticipate change. You have shown us things we never thought possible. Industrialization will transform us as it has you. Perhaps your experience can ease our way."

Muldoon's jaw dropped. "So that's why you're interested in this investigation. You don't care about the crime itself. You're looking for root causes, and how to correct them before they grow."

"Indeed," Grauw said.

I was several jumps behind Muldoon. "Industrialize? Huxlon? Mr. Ambassador, I'd understood that your world doesn't have the metal ores for that."

'No, we have them, but they are impossible to mine and process with our present technology—or lack of it? But the situation presents no difficulties when met with what your world has."

"Which implies we're going to help you to industrialize." Muldoon sounded awed. It isn't every day that you stumble over a national secret.

"Yes. Our governments have an agreement to that effect. Your president has emphasized a need for secrecy, at least in the present." Grauw shrugged. "I fail to understand the need, but we have agreed to comply. I would ask you to do the same."

"Damned right," I muttered, while Muldoon nodded. My situation was the opposite of Grauw's: I couldn't understand the reason for any such agreement, but I could sure as hell see the need for secrecy. Never mind that the Brotherhood and other chauvs would scream bloody murder. A policy like this is always full of unknowns, and that's always upsetting. John Q. Voter would get nervous and suspicious, and a lot of sober politicians would use this as a weapon against the Administration.

A couple of drones came in with food platters, and Grauw steered us away from business while we ate. He had a plateful of something that looked like moss, while Muldoon and I had hamburgers. Mine was good, although the bun had been sliced from top to bottom, leaving me to work on it sideways.

Plates, cups and utensils had been made from clay. Like Hronk's tools, the shapes were functional, but artistic. Perhaps that shouldn't have surprised me. Without industries like ours everything has to be hand-made, and a good artisan will take pride in her work. "Your wife does beautiful work," I remarked.

"Czhal?" Grauw asked. He made a grinding noise deep in his throat. "Pardon—pardon my laughter. Czhal is my spouse, not Hronk. I fear Hronk did give

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the wrong impression when she talked with you."

"My mistake," I said. I decided to change the subject. "She seems concerned over the enclave's safety."

"That is understandable," Grauw said. "Both she and Czhal did bring children to Earth. Hronk always doubted the safety of this, and the attack strengthened her fears."

"Couldn't you have left the children on Huxlon?" Muldoon asked.

"I do not see how." I'm sure Grauw was perplexed. The tip of his tail was slowly slapping against the floor. "The purpose of a family is to raise and protect children, is it not? And it is Czhal's judgment that Earth is safer than Huxlon."

After seeing that tape of a vrakh, I could believe him. There are some things more formidable than New York hoodlums, although I'd rather not be quoted on that—civic pride, you know. "Things should be safer now," I told him. "Aside from the officers we've detailed to stand outside the enclave, we have a special unit in the area. It's trained to stop trouble before it starts."

"Hronk knows this, but it does not reassure her. We are hearing distressing things since yesterday. For example—" He put his plate aside and took a sheet of paper from his desk. "Here is an article from your *Herald*, concerning the Handyman ruling."

I took the printout and skimmed it. Some two-bit politician had shot off his mouth, comparing the huxloni to monkeys and saying that the Handyman decision was a cornerstone of civil rights. Dilute our rights by sharing them with animals and we would end up with no rights at all. "It's nonsense," I said, returning the paper to Grauw. "The Supreme Court has ruled that you have the same rights as humans."

"I know, but that is not the problem. It offends; Hronk is especially displeased. Such statements—" he shoved the paper into a drawer "—suggest that humans do not wish to deal fairly with us. Czhal and I know this is false. We need some way to disprove it to our people."

"You can't," I said. "The only thing you can do is to wait and judge by events. Most people know that this guy, and the ones like him, are talking nonsense. In the end they'll fade away."

"Yet they receive much attention," Grauw said.

"That's human nature," I said. "If someone tells you there's trouble, you'll listen to him, on the chance he's right. It takes time to show he's wrong."

"It shouldn't, though." Muldoon said. "Mr. Grauw, the real problem is that people are scared of changes—until they get used to them. Then they can't imagine how they lived any other way."

"So you, too, counsel patience?" He sighed, so noisily that I decided he was imitating a human gesture for our benefit. "Very well. I would like to ask more about your investigation. Your questions implied that the mugging involved more people than I did fight. Do you have suspects?"

I nodded. "Right now we're investigating the Human Brotherhood, but we think more people are involved. It's going to take some time to collect all the evidence we need. The legal procedures are time-consuming."

"We do have an alternative," Mul-

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doon said. "Under the terms of the treaty our governments signed, we have special powers to obtain evidence and compel testimony. We haven't used those powers yet."

"Indeed?" Grauw sat up. "May I ask why not?"

Damn Muldoon. "It's because I think using them is a bad idea," I said. I pulled the treaty writ from my pocket and handed it to Grauw. "That paper gives me the right to collect any evidence I need. The trouble is that it suspends the laws that protect basic rights. If I use it to extract evidence from the Brotherhood, people are going to see that as a threat to their own rights."

His tail-tip continued its slow twitch. "How can anyone see justice as a threat?"

"It's not justice that worries anyone, sir," I said. "It's rights. If we suspend the rights of one group today, we might do the same to other people tomorrow. And to more people, the day after. It's happened before."

"So by protecting these rights, you protect your society from itself." Grauw nodded. "The logic is admirable, as is the restraint demanded. I see the wisdom of this—"

There was a chattering in the hallway, and the young huxloni I'd seen before trotted into the office. Grauw said something to the kid as it climbed onto his lap. "Is that your child?" Muldoon asked.

"Mine and Czhal's, yes. Oh, in a sense my three co-husbands and I are all her father, but as you can see . . ." Grauw scratched her head, and I noticed that the child's fur bore a black *V* like his. ". . . . Zhyuf is my daughter."

"You sound proud of her," Muldoon said.

"I am. Some day she will be famous and have many husbands—the Good Gods willing," he added. He ruffled her tourist shirt. "But you are not here to listen to my pride."

So we talked some more about the investigation. Zhyuf stayed on Grauw's lap—and I sensed something odd with their affection. I couldn't identify it, but my intuition told me I was missing something here.

Hell, maybe I was just jealous. My daughter held no affection for me.

Eventually Grauw ran out of questions and we left the enclave. Muldoon and I remained silent until we were alone in our car. "Sergeant, I don't appreciate being put on the spot like that," I told her. I was ticked off by her mention of the treaty writ.

"Yes, sir." She hesitated. "I'm sorry, Lieutenant."

"Just don't pull something like that again." And with that, I decided to let it rest. I could understand why she wanted to hit the Brotherhood with everything we had; deep down, I couldn't say she wasn't right. "What did you make of what we saw in there?"

Muldoon stared out the windshield as I pulled into the traffic. "I wonder who's in charge there."

"Grauw is the ambassador."

"Which makes him an intermediary between two governments . . . and a male representative of a female-dominant culture."

"Dealing with a male-dominant culture," I said. "What are you getting at?"

"I'm not sure, Lieutenant. But there's

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this. Fact: a huxloni female's status is proportional to the number of her husbands. Fact: there are two married females in the enclave, Hronk and Czhal. fact: there are eight adult males in the enclave. Fact: Grauw said that he has three co-husbands."

She let me put it together. "Four husbands apiece. So Hronk and Czhal are social equals. What do we know about Czhal?"

Muldoon hesitated. "The enclave roster lists her as a 'policy counselor.' "

"That could mean anything."

"Yes. Well, Grauw always consults her before and after he deals with any humans. And yesterday Czhal made the enclave's official statement about the mugging."

"Which implies that she runs things," I said. While keeping a low profile, out of deference to human sensibilities, or out of a disdain for human contact? Did she share power with Hronk, or was Hronk just here to earn the rent? I wondered if the answers had a bearing on the investigation.

The radio queeped, breaking my train of thought. "Car seventeen," I answered.

Ling spoke. "Lieutenant, have you seen the news?"

"No." I looked at the traffic—fairly light, for Manhattan—and turned toward an empty curbside. "What's happened?"

"It's the Grauw case, sir. You made the front pages."

Muldoon took a news sheet from the glove compartment and turned it on. She looked startled, and she gave the sheet to me. The headline took up the top half of the page: *IMPARTIAL JUSTICE? Alien Murder Investigator Belonged To Human Brotherhood.*

I spent the rest of the day in my office, catching up on paperwork. Commissioner Goldbaum called me just before five and told me to be in her office at nine the next morning. I told her I'd show up, and I went back to work.

Around midnight I knocked off, went upstairs and bedded down on a lounge sofa. I read the news for a while, and found that it was as bad as it could have been. Someone had found one of my ex-squadmates, a man whom I'd long since forgotten, and he had told the whole truth about me. I had quit the Brotherhood over money, not ethics; I had been as violent and malicious as any other shock trooper—one of the best, as I'd claimed at the time.

My recent actions said I hadn't changed. Around midnight the news services reported that I had the treaty writ, that it gave me *carte blanche* to move against the Brotherhood—and that I refused to use it. No one said anything libelous, but I was smeared as a rabid, stupid bigot. The Brotherhood was applauding me, but everyone else wanted my head on a platter.

I spent a sleepless night on the sofa. My fling with radical politics was a matter of record, and so what? It was news to the public, and timing is all. Tomorrow Goldbaum would ask me to quit the case—that was as inevitable as the sunrise—and possibly to resign or retire. I'd never have the chance to clear my name.

Who had talked about the writ? I went over the list of who knew about it. Muldoon? No, a dumb move like that would

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wreck her career, and if nothing else she didn't make dumb moves. Grauw? He would have told Czhal, I suppose, but not any humans. That left McAdoo and Goldbaum, and they had no motive to tell.

Warner had motive, but no knowledge . . . although his image gnawed at me all night, jeering and smirking, smugly hinting at conspiracies and secrets he knew—

And I had my first break.

I slept for a couple of hours, got up and tidied up. Reporters were five deep outside the station that morning, and I needed a flying wedge of cops to clear a gap for my car. I saw mouths working, the words lost in the babble: When are you resigning? How goes the cover-up? Get any new orders from the Brotherhood?

Goldbaum was in her office when I arrived—with McAdoo. "I don't want your resignation, Omar," Goldbaum said before I could speak. She looked as if she'd gone without sleep the past night. "I want to avoid that. But I'll have to take you off the Grauw case."

"I understand." I looked at McAdoo. "But I want a chance to clear my name. There's been a leak; I want to know who told the media that I wouldn't use the treaty writ."

McAdoo looked offended; he knew what I was implying. He kept his voice level. "If you have something to say—"

"I do. Who knew? I told Sergeant Muldoon, but I can trust her. I told Grauw, but who would he tell?"

"The huxloni enclave could be bugged," Goldbaum said.

"It has good electronic security," I told her. "It would take a major effort to penetrate it."

"That's true," McAdoo said, and sighed. "The Secret Service maintains its own watch on the enclave. It hasn't been penetrated."

I nodded. That admission said he was innocent—but it didn't clear him. "Commissioner Goldbaum knew, but she's not going to sabotage her own department. So, Mr. McAdoo, who did you tell?" I did my damnedest not to sound accusatory.

He sighed again. "Lieutenant, last evening I had dinner with the president. I mentioned your reluctance to him and a few of his advisors—all of whom have enough sense to keep their mouths shut."

"Do they?" It was time to gamble. "Then which one of them talked about the government's plan to gengineer the next generation of Americans?"

I had him; his shock showed. "It's true, isn't it?" I asked.

"I must know who told you," he said flatly.

"Sergeant Muldoon and I got it from the local head of the Brotherhood. Mr. McAdoo, you can bet you're on a first-name basis with whoever passed the word to him."

McAdoo nodded and sagged in his chair. "It could be one of several people . . . but . . . *why* . . ." He shook his head at the betrayal.

"Someone has a motive," I said. "Count on that. But I need facts."

"How much do you know now?" McAdoo asked.

"Ambassador Grauw told me that we're going to help the huxloni indus-

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trialize. He asked that be kept secret, of course."

"He couldn't understand the need for secrecy," McAdoo said musingly. He looked up at me. "Do you think much about the future, Lieutenant? The *whole* future, the future of the human race?"

"I can't say that I do."

"The president does. Unready as we are, Lieutenant, we're out in the galaxy now—and we can't conquer it, we can't rule it. All we can do is make a place for ourselves. . . . or stay on Earth and die, one day after another.

"The president is trying to make that place. The huxloni—it's too late to ignore them. If we walked away from them, right now—well, you've dealt with them, Lieutenant. Do you honestly think they would remain where they are, trapped on one world in a permanent stone age?"

"I don't know," I admitted. "They have no iron, no copper—"

"Trivia," the man said. "They have traces of those metals, and now they know that other metals—aluminum and magnesium and other things—can be extracted from dirt and rock. . . . and now they know about electricity and magnetism and a hundred other things. They may not have the theories, *yet*, but there are no secrets in science. Especially when you know a thing is possible."

McAdoo got up and walked to the window. As Goldbaum and I watched him he depolarized the glass and looked out at the city. "This won't change if we pretend they don't exist. Given those minds of theirs, they'll surpass us within a century. If it pleased them they could dominate us. They probably would; expansion is a basic fact of economics—and economic rivalries lead to wars, more often than not."

Goldbaum looked dubious. "I'd always heard that interstellar wars are impossible."

"Everything we know suggests that," McAdoo agreed. "But do we know everything? And do we bet the future on that?"

"What are we betting on, then?" I asked.

"Peace. Prosperity. Profit." He turned to face us. "We can't have the huxloni as rivals, so we'll be partners. . . . with them, and with the next race we meet, and the next, and the next. We want to build an interstellar version of the European Common Market."

"You can't know that that'll work," Goldbaum said.

"No. It's a gamble. What isn't, this side of the grave? And to maintain parity with the huxloni, to keep from ending up as junior partners or clients, we're going to enhance the next generation, gengineer them for better, sharper minds. We'll need that edge."

I saw the look on Goldbaum's face. She seemed as unsettled as I felt. McAdoo had just made us stand on the brink of the future, and *look*—and it was almost more than we could comprehend. I could sense myself straining for some sort of anchor. "That'll make a lot of people angry," I said at last.

"I know." McAdoo looked chagrined. "It's clearly upset one of the president's most trusted advisors. We've been hammering out this policy for weeks, trying to make it as palatable as possible. The work of industrializing the huxloni will stimulate our own econ-

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omy, with jobs and profits for everyone. The same applies for the gengineering project—we'll have to expand our biological resources enormously—labs, hospitals, personnel—education—''

'' 'Education'?'' I echoed.

''Propaganda, then. There are still certain prejudices to overcome.''

Suddenly I didn't want to hear him. If we had had a policy like this a generation ago, I might not have a family that hated me. If only . . .

''Expensive.'' Goldbaum spoke in a dry whisper. ''Very expensive.''

''Compared to planetary decline?'' McAdoo shrugged. He polarized the window again and went back to his seat. ''We can cover the expense—and there's one bit of luck. The arms races have been winding down the past few years. Uncertainty has done more than common sense to ensure peace—what good would it do anyone to conquer the world, if some other race could move in and conquer what's left? The stars make a very helpful threat, Commissioner.''

McAdoo smiled, almost cynically. ''And the economy may need our plans, to avoid massive dislocations. Peace is expensive when a major part of the economy is geared toward making and supporting weapons. Industrializing the huxloni and gengineering the race will keep the economy moving, and in the long run it will be more profitable for everyone.''

''Will it?'' I asked.

McAdoo gave me an odd look. ''Yes. Even when you *need* weapons, you don't recover much of the money you spend on them. Almost any other investment gives a greater financial return.''

''That's not what I meant. Some people profit from the current arrangement; what happens to them when things change? If someone thinks he's going to lose out—''

''I know, I know,'' McAdoo said curtly. ''I'm no detective, but I have my own tricks. There's a good chance I can flush out our traitor.''

''I can tell you that he's someone wealthy,'' I said. ''He's been funding the Human Brotherhood.''

His eyebrows arched up. ''You're certain?''

''What I have is circumstantial, but it looks that way. The Brotherhood hired that shyster Glenfield for Putnam, and he doesn't come cheap. The Brotherhood itself is almost insolvent.''

''Maybe I can use that.'' McAdoo stood, moving as if his joints hurt. ''Commissioner, can you keep Lieutenant Prynne on the case?''

Goldbaum gritted her teeth. ''I think so. It would help if I had some support from Washington.''

''I'll try to arrange that, but I can't make any guarantees.''

''In other words, forget it,'' Goldbaum said after McAdoo left. ''The president may be a visionary, but he won't stick out his neck, Omar.''

''I didn't think he would. How much time do I have?''

She looked thoughtful. ''Three, maybe four days. Right now everyone but the devil and the Brotherhood want your tuckus. Unless there's a break I'll have to oblige.''

''Then that'll have to be enough time.''

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I went back to the Tenth, where I bulled my way through the wall of reporters. I wondered which of them had received the leak about the treaty writ. If I could get that one name—but reporters are protected by shield laws, and I wasn't going to use the treaty writ to get around that.

I could sense people, my people, looking at me as I came in and went to my office. What were they thinking? That I was a fraud? That they couldn't trust me? Maybe I would have to resign after all; when you lose the respect of the people who work with you, you lose everything.

There was no point in postponing the inevitable. I called Muldoon into my office and motioned her into the guest chair. "You've heard the news."

She nodded. "Someone is trying to sabotage the investigation. Will it work?"

Was that all she had to say? "It could—tell me, Sergeant. What do *you* think of it?"

"Or of you?"

I nodded and let out my breath. "Yeah."

"Quitting because the Brotherhood was swindling you showed good sense—oh." She looked at me for a long moment, and I knew she was analyzing me. Then she nodded slowly. "You want to prove to yourself that you're not the same person who joined the Brotherhood."

"Yeah. Maybe I do."

"Lieutenant, a real member of the Brotherhood wouldn't be sensitive to anything like that." There was an odd respect in her dark eyes. "And one of them wouldn't have your scruples about using the treaty writ, would he?"

"I don't know any more." What was I doing—asking Muldoon for absolution? I didn't have the right. I rubbed my forehead, as if that could squeeze out some thoughts. "Maybe what I need is to do something—"

"To wreck the Brotherhood?"

"To keep them from wrecking things now." I'd made a mess of my life with bigotry. I couldn't change the past, but I could try to help the future.

Well, I'd get nowhere by contemplating my navel. "Sergeant, we have work. Goldbaum figures she'll be forced to take me off the Grauw case in another three days, four at the outside, unless something happens to take the pressure off."

"So we have a deadline." She was all business now.

"And something else. Maybe." I got up and went to the coffeemaker. "I was at Goldbaum's office a while ago. So was Alphonse McAdoo. You remember what Warner said about a government plan to gengineer children?"

"Of course."

With her memory, that had been a silly question. "Warner is in the know—somehow. The White House *is* formulating a new policy, and mass gengineering is part of it. We'll also help the huxloni industrialize, and use that to form a—business partnership, you might say, a trade empire. The president figures it's a choice between free trade and mutual prosperity, or rivalry and eventual war."

She was nodding. "The president knows history. And the gengineering will bring us up to the huxloni's mental level in another generation. That makes

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sense, but it'll mean restructuring the economy."

"Exactly." I handed her a cup of coffee. "It's the biggest thing since the New Deal, and when it starts a lot of people are going to feel that they're getting the short end."

"Ah."

"Ah, indeed." I tasted my own coffee as I sat down. God, my kidneys must hate me for drinking this slop. "Now consider this: someone in the know told the press that I had the treaty writ and wouldn't use it. Who knew and talked?" I held up a hand. "Not me, not you, not Grauw, not Goldbaum. But McAdoo told the president, and a few of his advisors—"

"I see." She got up and went to my terminal, moving like iron drawn to a magnet. I moved aside for her, and watched as she accessed data. Political data: gossip, news and statistics. After a moment she started asking me questions about McAdoo's precise words.

"Demilitarization is the key," she muttered. "Retooling is costly, and some things can't be converted to peacetime use. This assumes our suspect has an economic motive."

"Work on that assumption," I told her. It was possible that one of the president's men had a psychological problem—fear of genjees, fear of aliens, fear of change—but I was willing to bet that the president's judgment kept such people out of his inner circle.

"Eldon," Muldoon said at last. "Kingsley Eldon. He fits the parameters. He has the most to lose, and he had dinner with the president last night."

"Eldon? Of Consortech?" I shook my head. "He's not involved in weaponry."

"Not directly," Muldoon said. "But one of his subsidiaries makes composite armor materials, for tanks, ship hulls, aircraft and vehicles. Another subsidiary generates software for secure communications and battlefield management. A third makes weapon sensors and guidance systems."

"All of those have peacetime uses."

Muldoon nodded. "They do, but the profit comes from making improved versions—tougher armor, more efficient software, better countermeasures. In warfare, you either stay ahead of the competition, or you lose. You don't have that incentive for peacetime uses."

"So there go your R & D budgets and contracts for the next generation of weaponry." I felt grim satisfaction. "Sergeant, do you think Warner has a direct line to Eldon?"

"Absolutely not, Lieutenant. Warner may be that clumsy, but not Eldon."

"True." I had to smile. "But Warner knows that he has a friend in high places. Let's bring him and his staff in for questioning." I reached for the phone and started giving orders.

By my watch it took fifty-seven minutes to bring in Warner and his staff—good time, considering the traffic. I spent that time briefing my interrogation teams. Muldoon and I would work on Warner, but I had a hunch our real break would come with one of his underlings.

"I suppose I should thank you," Warner said, when we came into the interrogation room. "I don't know how many newspigs saw my arrest. You just can't buy publicity like that, Prynne."

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"You're not under arrest," I told him. I tried my level best to sound kind. "You're just here to answer a few questions about Kingsley Eldon. Industrialist, confidante of the president, philanthropist—he's given you a lot of money lately, hasn't he?"

He looked cold. "Prove it."

"In due time." I looked at the recorder. If Muldoon's guess was wrong, I had just put myself in hot water by slandering Eldon. Well, the water I was in was boiling now; how could it get hotter? "Let me tell you a few things. Eldon wants to destroy our relations with the huxloni. That's why he's been bankrolling you punks. How much did he pay you for this Grauw thing? Did he want a refund when Grauw got out alive—"

Warner laughed at me. "Prynne, you're bluffing! Don't ever play poker, you don't have the knack." He started to get up. "If you're through harassing me—"

"We're not through," Muldoon said. She leaned forward, resting her elbows on the table, and her smile was an unpleasant sight. "There are certain irregularities in your legion's finances—"

"You don't have our records."

"I don't need them," she said. "When I came into your clubhouse, I watched your recruiter collect fees of twenty-five dollars per recruit. Said fees were recorded as *fifty* dollars apiece. That's how you laundered Eldon's donations."

Warner looked pleased. "That will never hold up in court."

"Guess again. What I saw is legally admissible, under *Lehr v. McGill*, 2013. I quote, 'When an officer of the law, while performing his or her normal duties in good faith, sees displayed any open evidence of a felony—' "

Warner slapped his hand on the table. "You're a genjee freak. I should have known Prynne would use a thing like you—when a man turns bad, he goes rotten all the way. But do you really think a *human* jury would take your word over mine? After a good defense attorney works you over? Vengeful genjee, out to get the mean old chauv?" He shook his head sadly.

"You're forgetting your account books," Muldoon said.

"Oh, yes. Them." He went *tsk-tsk-tsk*. "They were lost when we shipped them to the home office. We've notified the proper authorities, all nice and legal. I guess no one notified you."

"We don't need the books," I said. Damn it, I had said something that told him I was bluffing, but I couldn't back down. "We have Eldon. Imagine how eager he is to save his bacon. If I was you—"

"—you'd talk, and hope the judge feels generous." Warner shook his head again. "Oh, no, mister straight-arrow, mister long-arm-of-the-law. I know everything you have, and everything you can get. All *that* can get you is a long, messy trial. Think of what they will do for the Brotherhood."

"Think of what a long, messy prison term will do for *you*," Muldoon said.

"I've been in jail before." I don't think his indifference was an act. Some people see prison as an opportunity, a chance to organize a gang and plan for the future. Beyond that, Warner must have seen it as a chance to generate power, to give himself a martyr's image. That image would only appeal to

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other lowlifes, but lowlifes made up Warner's world.

"You'll be in prison again," I told him. "Simple advice for a simple mind, Warner—cooperate while you can. You're running out of time, unless you count hard time."

"Who, *moi?*" He laid a hand over his heart. "Prynne, you're the one with no time. Public opinion is swinging our way."

Muldoon snorted. "Don't believe everything you hear on the news."

"Stuff it, freak," he said casually. "We're getting a better class of members now. Respectable folks, with real money—that's how I know." He eyed Muldoon. "Want to know which of your fellow cops belong to us? We have members right in this building."

"I already knew that," I said. "And God help them when I find their names."

Warner tut-tutted me. "God help you if you touch them, Prynne. Look. Maybe you'll break things wide open. Maybe I'll go to jail. So what? People will remember it was the Brotherhood that showed how dangerous these aliens are. They'll remember we stood up for humanity, when their own government wanted to sell them out. So how long will it be before I'm pardoned, Prynne? A year? And how strong will the Brotherhood be when I'm out again?"

"Pipe dreams," I said.

"Really?" He drew the word out. "People always look out for their own interests, Prynne. Even the people who won't join us will be glad we're around—even the hypocritical bastards who condemn us. They don't want the world turned upside down."

"And you think you'll set it right-side up for them." I felt uneasy. Did Warner have a touch of megalomania? Or did he see a human weakness he could milk for profit? I couldn't say—but I knew how frightened people can be of change. Changes as enormous as the ones envisioned in the president's new policies were bound to be matched by a stiff backlash. . . . and the Brotherhood was making its bid for leadership of the resistance.

The intercom came on. "Lieutenant Prynne, we have something," an interrogator said. "You'd better hear it. We're in room six."

"I'm on my way." I nodded to Muldoon, and she followed me out.

Phyllis Ambrose, Warner's secretary, was in room six with a pair of woman detectives, Salas and Hille. They both had the satisfied looks of detectives who just had a major break.

Ambrose looked up at me as I entered the room. "They said you'd move for leniency," she said.

"If what you have is good. Geek," I ordered.

She geeked. "I have the ledgers you wanted." She ran a hand through her short, graying hair. "After you showed up, Mr. Warner told me to burn them. I—look, I've been in jail and I don't want to go back. I took the books home and hid them under my bed."

"There's more." Hille was leaning against the wall, arms folded over her chest. "Tell him about the messages. And Grauw."

"There was a courier," Ambrose said. "A man called Slick. Mr. Warner knew him in Attica. He brought money and messages, four, maybe five times, from somebody in big business. I never

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met Slick, but sometimes I heard Mr. Warner say what he wanted. The last time he called, he wanted an alien attacked—but not killed. We weren't supposed to hurt it."

Huh? "Why not?" I asked.

"I don't know, no one discusses policy with *me*."

Yeah, sure, she was an innocent bystander. "Keep talking," I said.

"Mr. Warner called in two troopers one day. He told the kids to steal the alien's pouch, and scare it a little—shake it up, frighten it, wave some knives in its face—"

"Stick to the point," Salas ordered.

Ambrose took a breath. "The hit men weren't supposed to have any connection with the Brotherhood, so Mr. Warner erased Putnam and Waleski from the membership rolls. The alien was supposed to kill them, so they wouldn't talk. No one expected you'd investigate us."

Right. No one ever thinks they'll get caught. "So when Putnam lived, you had to find another way to keep him quiet," I said.

"Glenfield," Ambrose said. "Mr. Warner hired him to intimidate Putnam, and to muddy the waters. Hiring Glenfield cleaned out the treasury, but there was no other way, only a lawyer could visit Putnam and—look, this is just what I heard. I wasn't involved."

"How noble," Muldoon said. "You let Putnam and Waleski go out as sacrifices. You knew—you *knew* Grauw could take them."

I was nodding. "You people just didn't know that Grauw wasn't vicious. He killed Waleski by accident, because he overestimated how tough he was. Grauw was more careful with Putnam. Did this contact of Warner's tell him where to find Grauw?"

"Yes," Ambrose said. Her voice was barely audible. "That's all I know. You promised to move for leniency."

"I'll tell the DA." I looked to Salas. "OK. Book her, then get the ledgers and give them to Forensics. Then get out to Riker's Island and see how Putnam feels about being a human sacrifice. I'll bet he talks now."

They left. "So that's how Warner knew I was bluffing," I said, sitting down at the table. "We assumed Putnam and Waleski were out to kill Grauw. Warner knew better. We're lucky Ambrose cracked." When I thought of the stink Warner could have raised if we'd had to release him after this. . . .

"It wasn't luck," Muldoon said, seating herself. "She was ready to crack from the start; she kept the ledgers as insurance, to buy herself an out with us. Do we book Warner now?"

"Warner, and the rest of them. And Glenfield. Murder, attempted murder, conspiracy to commit murder, conspiracy to conceal and destroy evidence—you can draw up the charge list, Sergeant. And then we're going to Washington. I hope to God Eldon is our man—and I want to know what he had in mind."

Muldoon nodded absently. "Killing Grauw would make sense, but setting him up as a killer—I don't get it. I can see possible motives, but they could backfire too easily." She stood up. "Meanwhile, do you want to tell Warner it's all over for him?"

I didn't even hesitate. "No. He isn't worth my time."

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We met McAdoo in his Georgetown office, and drove with him into Arlington, where Kingsley Eldon lived. "There's no question of Eldon's guilt," McAdoo said, as his limousine cut through the late evening traffic. "The FBI checked his actions last night, after he left the dinner party. He made several calls to New York numbers—to reporters, the same ones who broke the story about you and the writ. He was seen using a phone booth in a shopping mall, of all places."

"He handled it himself?" I asked.

"He wanted to keep outside involvement to a minimum. And he has a multilayered contact with this Warner. Eldon gives money and messages to an old friend, an attorney in Philadelphia. She passes everything on to her gardener, who did time in Attica with Warner. The gardener shuttles between Philadelphia and New York. This has been going on for three or four weeks."

Muldoon nodded. "Eldon has been using the Brotherhood as a political tool, hasn't he? A publicity gimmick, to persuade the huxloni that most of us hate them."

"Quite true," McAdoo said. "He's paid the Brotherhood a bounty for each new member, along with paying for the attack and Glenfield. He's also given them advice about using the news media to maximum effect."

"The rumors," Muldoon said to me. "I should have guessed this. Right after the attack, the Brotherhood had nothing to say—"

"They were caught off-guard when Putnam lived," I said.

"—but there were all those false news stories," she finished. "They hired people before the attack to spread the rumors. It was an application of the Big Lie concept. If Grauw was blamed, often enough and loudly enough, the blame would stick."

I nodded. "And if one rumor wasn't believed, another might be."

"There's worse," McAdoo said. "This may have revitalized the Brotherhood. Their membership has been increasing all across the country, and Eldon's assistance only accounts for part of the rise. I hope it's only a fad—there are always people who think anything in the news is fashionable—"

"Nobody joins something like the Brotherhood for a lark," I said.

"Yes." McAdoo lapsed into a grim silence.

We drove onto Eldon's estate, went to the front door, and waited for a human butler to admit us. Maybe I should have felt out of place here, but I didn't. Eldon was just another perpetrator, and his affluence didn't change that.

That was my gut feeling. Intellectually, I knew he wasn't going to go to jail, or even get his wrists slapped in court. All I could reasonably expect from Eldon was a few answers, a few sentences which would let me close the case. Tomorrow Muldoon and I would see Grauw, and we would tell him how we had wrapped up the investigation. I wondered if what I told him would help his world avoid corruptions like ours. . . . or if some day huxloni detectives would study this case for insights into new troubles.

I was feeling very old.

Eldon didn't seem troubled when he met the three of us in his study. It was

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an elegant room, tastefully appointed, perhaps worth as much as a suburban house, possibly more. "More FBI agents?" he asked McAdoo, as he seated himself. "I've already had a long day, Alphonse."

"My heart bleeds," McAdoo said. "Lieutenant Prynne and Sergeant Muldoon are from the NYPD. They're conducting a murder investigation, and you don't have immunity."

"You know this will never make it to court," Eldon said. "I—"

"The president feels betrayed," McAdoo said. "And you know how much the huxloni policy means to him."

"His big chance to make the history books," Eldon murmured. "Another Lincoln, another Roosevelt, setting the course of the future. And all that rot." Eldon raised his voice. "He can't afford trouble with me. He needs all the support he can find."

"Why, so he does," McAdoo said. His smile showed neat, sharp teeth. "And he doesn't care how he gets it. If he has to frighten certain people by making an example out of you, he will. But he'd rather be able to point to you as a wonderfully cooperative—"

"Yes, yes." Eldon waved a hand and looked at me. "Are you Muldoon, or Prynne?" His voice said he didn't much care.

"Lieutenant Prynne—"

"And you want to know why I involved myself in this whole sordid business."

"We already know that," I said. "Your motive is profit. The huxloni policy will put you out of business."

"Then you know *nothing*," Eldon growled. He fixed his eyes on McAdoo. "This disarmament mania—it's true, no one can chance a global war. We can't risk exterminating ourselves. But if we disarm, let ourselves turn soft, we risk ending as a satrapy in some alien empire."

McAdoo looked impatient. "We've been over this line before. Even Walters doesn't buy it."

Walters? It took me a second to place the name: the defense secretary, and a born hawk. "What's this about?" I asked.

"The safety of the human race," Eldon said. "We'll meet other races out there, and it's a certainty that some of them will be aggressive. That makes wars inevitable—Consortech has done studies to prove that. Right now we have a skill at creating better weapons and tactics. We can't throw that talent away."

Muldoon looked to me. "So it *was* a profit motive, Lieutenant, but it was more complex than I thought." She ignored the glare of anger on Eldon's face. "He wanted to make the huxloni look dangerous, the first of many threats."

"And you need guns against threats," I concluded. Is it an instinct with us, to fear the unknown? Eldon thought so. Maybe he was no different from Warner, not where it counted. Eldon was smoother and more couth, but he had found his own way to profit from human frailty.

Muldoon looked to McAdoo. "The arms business is turning moribund," she explained. "A new threat could revive it, so Eldon created one. First he needed a climate of hate, so he picked up on the Brotherhood. Probably he's pulled some strings among the media, to ensure that there would be a maxi-

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mum of negative reportage against the huxloni.

"But the attack was the important event. With luck, Grauw would have looked like the vicious killer of two innocent youths. But if they were exposed as common criminals—"

"Grauw would still look dangerous," McAdoo finished. "A natural fighter who easily defeated two armed, vicious criminals. Even though it was self-defense, you can't ignore the fact that he, and the rest of the huxloni, have evolved as better fighters than humans. You're left with an illusion of menace."

"It's no 'illusion' " Eldon told him. "I *know* the huxloni are a menace. They're only posing as harmless, friendly people—sparing that one kid's life was just a clever ploy. The huxloni are Machiavellian on a scale you can't imagine."

I wondered if he believed that. "Prove it," I said.

"I will," Eldon said. "When I made my arrangements with the Brotherhood, I told them where and when to find Grauw alone. Do you know where I got that information?"

"Oddly enough, we're here to ask you that," I said.

Muldoon caught something I'd missed. "Who told you?" she asked.

Eldon looked as if he had just made the winning move in a complex game. "Her name is Hronk."

The president and his advisors were in a dither. They had taken it for granted that the huxloni wanted to play ball. Hronk's action had come out of left field, upsetting everything. What was going on? There were a number of possible explanations, but no one could guess her motive . . .

. . . and then someone decided that "motive" was a matter for the police. Specifically, it was something for two cops with access to the enclave. Muldoon and I were briefed and sent back to New York.

There were no crowds in front of the huxloni enclave, not now; the department had put up barricades. It had been three days since Warner's arrest, and there had been dangerous rumblings from the Brotherhood in that time. We had word that the Brotherhood's shock troops were infiltrating the city, in twos and threes, mobilizing to attack the enclave. They were sure they could get away with it.

"One thing," Muldoon said quietly, as we walked up to the enclave's front door. "You really shouldn't count on me being as fast as Hronk."

I snorted in the chill morning air. "I'm counting on you being better than her. And not missing your cue."

One of the drones let us into the enclave and took us to a common room. Muldoon and I would have to stay on our feet, I realized; there were no chairs or other non-huxloni furnishings. Grauw was there, along with several other huxloni. One of them was standing quietly in a corner: a drone, waiting for orders. The other two were seated side by side. One was Hronk, and the other—"You must be Mrs. Czhal," I said.

"I am. I believe you are Prynne." She looked me over, but she ignored Muldoon—by her standards Muldoon was a drone, and thus beneath notice. "When you called, you did say that you

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would explain the attack on my second husband. Do so.''

''Of course.'' Czhal seemed as abrupt as Hronk. I suppose that was inevitable; both of them had high status in a hierarchical society. By their standards Muldoon was on the bottom, while I—well, just where did a male fit in? But for my own safety I was counting on Hronk's disdain of Muldoon.

''First of all, no one wanted to kill Grauw,'' I said. I looked at Grauw, whose ears were twitching in surprise. ''The man who ordered the incident set it up that way—he was certain that you could, and would, kill Putnam and Waleski. The purpose was to make you look dangerous.''

Grauw caught on at once. ''And thus all huxloni would become objects of fear and suspicion. An elegant ploy. Can you explain his motive? I trust it is not too alien for our comprehension.''

I almost smiled. ''No, you can understand it. Mr. Grauw, can you tell me how you feel about Zhyuf's future?''

''My daughter's future? I—I do not know what to say.''

''I do. You're afraid that she might end up as a drone, aren't you?''

''That is a natural fear. She—'' He made a strange noise. An alien sigh? ''No one's future is assured,'' he said quietly.

''No.'' Hronk was eyeing me; it was time to move. ''I just now figured this out—''

Muldoon's gun roared. I had *seen* it happen; Hronk had thrown a knife at me, and Muldoon had shot it out of the icy air, shattering the clay with her bullet. Two blurs of motion, a flash and a roar, and then Muldoon was holding her revolver on Hronk. ''Don't move,'' she said.

Hronk held still, but she spoke to Czhal in huxloni. Czhal answered while Grauw addressed me. ''Please, accept my apologies for this—inhospitality. I can see no explanation for it, none at all.''

''I can. I know her secret. She wanted to kill me before I could tell it.'' And I had called the—quite literal—shots correctly. By suggesting that only I knew her secret, I'd effectively invited her to kill me. Risky, but it exposed her to the other aliens.

''Secret?'' Grauw asked.

''I'll explain, if you'll bear with me. How far is your society going to change, once things get moving?'' I held up a hand before he could speak. ''Specifically, what happens to your social structure? Will you keep the polyandry system?''

''I could not say. It serves us well.''

''Because you have to keep your population down.'' Muldoon spoke without taking her eyes from Hronk. ''But technology will give you larger food supplies, and you'll need a larger population to run a technological society. Plus, it won't be long before you're colonizing other worlds. You'll need more numbers.''

''Grauw, you'd like that,'' I said. ''If things work out, Zhyuf is bound to get a husband. In fact, there won't be any more drones, which means—''

The drone in the corner left the room, almost running, and from the hall I heard her wail. I felt almost ashamed, but what could I say? Sorry, sister, you were born one generation too early?

Czhal put human-sounding annoy-

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ance in her voice. "Speak with relevance, *man*. I wish to know of the assault."

"I'm speaking of it. What happens to class and status when your social system is swept away?"

"We will adapt," Czhal said. She snorted, an angry sound, her breath steaming in the cold air. "If it displeases us, that is no *human* concern."

"We change, become human," Hronk said. "Change comes, upset follows. Upset weakens, humans conquer."

"They will conquer us if we stay as we are," Czhal said. "I have spoken."

I nodded. "You're senior to Hronk. You've been married longer than her?"

Was Czhal scowling? "That is astute. What of it?"

I did smile then. "What if one of your husbands—Grauw, for example—died? Would Hronk outrank you?"

"In many ways." She looked to Hronk. "But still I would have the mandate of the All-Mother."

"Along with a power struggle," I said. I looked to Hronk. "You meet a lot of humans at your art showings, don't you? And you don't like us."

"No respect, no . . . *spualt*," she said.

" 'Awareness of lower position,' " Grauw translated. "As aliens, you do not appreciate the enormous gap between yourselves and a lady with four husbands. You are offensively familiar."

"We're not deferential enough," Muldoon said. Her gun remained locked on Hronk.

"The very word," Gruaw agreed.

"And there's her motive," Muldoon said. "She's faced with a loss of status if your society changes. It's as if a queen suddenly became a commoner. No wonder she loathes us."

"But Hronk can recognize a kindred soul," I said. "Such as Kingsley Eldon. He doesn't hate huxloni, but he *does* hate what the president has in mind. The changes that are coming in our societies—he and Hronk have that in common. The fear of what they'll lose. They'd both like it if relations soured. And if Hronk could displace Czhal—it was her suggestion to kill Grauw."

"You wrong, Eldon suggest," Hronk said.

"It doesn't really matter," I told her. "You thought Eldon would arrange to kill Grauw. You couldn't know he had other plans when you told him where he could find Grauw, alone and unprotected. It must have looked like a good deal, Hronk. The aliens kill Grauw. Czhal loses status, you gain it, and the murder makes it easier for you to drive a wedge between our worlds."

I think she was ready to kill me. "Wedge human, not people."

"She means the Brotherhood," Grauw said. "And the other—'chauvs' is the word, is it not? They are the wedge."

"Chauvs fight, block change." And Hronk made the noise I thought of as alien laughter. "I win, no change."

"Damn you," I said quietly. I'm no great thinker, but I could see the promise that the president's policy held for humanity. And that promise was being torn apart for nothing. For a man who wanted profits, for a greedy bigot, for a matriarch clutching her prestige. They had ruined the future of two worlds. "You get what you wanted, Hronk."

"Maybe not," Muldoon said. She

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holstered her pistol. "Lieutenant, I have an idea."

I've faced press briefings before, but not like this. The conference room was crowded, and there was not one friendly face to be seen. Worse, many of them looked like they expected me to lie. I could see them composing their editorials now. Bigot cop covers up for Human Brotherhood.

The hostility grew as I outlined events, starting at the beginning. There had been a dispute in the huxloni enclave; Czhal had wanted better relations with Earth, while Hronk had feared that contact with us would upset her society, depriving her of her social rank—

"What's this got to do with the assassination attempt?" someone shouted.

"I'm coming to that." I glared at the man for a moment before I went on. "It has to do with the way huxloni society works. Czhal is in charge of the enclave, but she's only slightly senior to Hronk. They both have four husbands, which by huxloni standards makes them both powerful, and near-equals. Now, if something fatal happened to one of Czhal's husbands, she would lose status, and Hronk would take over—"

The reporters started babbling, then began shouting questions. I waited until I heard the one I wanted to answer: "Are you saying that Hronk was responsible for the attack?"

"I'm saying she was one factor. Another factor—" I waited for the noise to settle down. "She couldn't arrange an assassination by herself. Hronk knew she needed a human accomplice, someone who also had something to gain by destroying interspecies relations.

"She found her man in Kingsley Eldon. It seems the president is hammering out some agreements with the huxloni. I don't know the details, but Eldon does, and he doesn't like them. He decided that they'd cut into his profits, so he took it upon himself to help Hronk wreck things between Earth and Huxlon."

I had the room's attention now. "Eldon was already in touch with the Brotherhood; he was slipping them money and advice. He figured that if they made enough noise, it would help him to block the president's huxloni policies. So he bought noise.

"Then Hronk met him, sounded him out, and made common cause with him. She wanted Grauw killed, and she told Eldon when and where to find Grauw alone. Eldon took that information—but he went one better. He didn't need Grauw killed; that might make sympathy for the aliens. But if he could make Grauw look like a killer, a monster from space—well, public opinion would turn against the huxloni, and there go any agreements.

"So Eldon sent some instructions to the Brotherhood. Send a couple of punks to attack Grauw—but make sure they couldn't win, make sure they'd get killed. It didn't work because Grauw isn't a killer, no more than the average human—"

My voice was drowned out again; damn it, how can a hundred alleged adults each act like they're the only one in a jam-packed room? I pounded my fist on the podium until I got a reasonable amount of order. There were still a few shouted questions, only one of

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which mattered: "Are you saying the Brotherhood wasn't to blame?"

"They've got blame," I said. "But I'm also saying they were being used, from start to finish. Hronk was using them and Eldon was using them, and none of them had the brains to ask what was going on. They just took their money and did whatever they were told.

"And they came *cheap*. Eldon paid them less than twenty thousand dollars, all told. For him, that's chump change."

There was laughter. It was quiet, now, but it would get louder. I started taking questions after that, but none of them mattered. I'd just said the important things.

I spent that Friday afternoon cleaning out my office. Most of the stuff went into the wastebasket; there wasn't a whole lot that I wanted to take into retirement. A few plaques and framed holos, a beer stein that served as a pencil holder, a malachite paperweight, the rug—that was about it.

Muldoon came in as I finished up. "The Tenth isn't going to be the same without you, Lieutenant."

"It'll be the same," I said. "Come Monday morning, you'll be so busy with perps and citizens you won't even know I'm gone. Or are you just trying to get out of the extra work, Lieutenant?"

"It's still 'Sergeant,' " she said. "My promotion doesn't take effect until Monday morning. But—don't you look like you're leaving under a cloud?"

That surprised me. "What makes you think that?"

"There were those accusations of covering up for the Brotherhood—"

I laughed. "Sergeant, you may be the only person in New York who remembers that. Right now, I'm one of the two people who cut them down to size. That's a good way for me to go out." A very satisfying way, I thought.

"I see."

"And you're coming in with a good reputation, and don't knock that. It'll be a big help."

"Yes. I wonder if I should thank the Brotherhood?"

"I'd doubt they'd appreciate the sentiment." They were still in business, but their fortunes had taken a nose-dive since the press conference. The troopers who had snuck into New York to prepare for a battle were slinking away—and quitting the Brotherhood.

It's a funny thing, human nature. People will forgive their leaders when they lie to them, rob them, even kill them . . . but one thing they won't forgive is a leader who makes them look like fools. The Brotherhood's leaders did exactly that, when they were exposed as the tools—hell, the dupes—of an industrialist and one hated alien. Humiliation is a fatal disease for causes; only the small, hard core of the Brotherhood was immune to it.

The president's policies were going ahead. Under other circumstances the public might have been leery of them, but not now. They looked at the sort of people who had opposed the new order, and decided they were bigoted crooks who were trying to rob them of something valuable. That made the huxloni policies attractive; when someone tries to take a thing from you, you hang on with both hands, even if you're not too

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sure what you're holding. That's human nature, too.

I looked around the office. There was no way to tell I'd spent twelve years behind that desk; I might never have been here at all. But I knew what I'd done while I was here, and why. That was what counted. ■

FUTURES

(Continued from page 61)

stretch the limits of what a game can do. As one of the designers, Noah Falstein, once told me, "we're all trying to make Dream Park"—referring to the classic novel by Larry Niven and Steven Barnes.

I have to admit to some disappointment in their new release, *Indiana Jones and the Last Crusade—the Graphic Adventure* (Lucasfilm Games, Box 2009, San Rafael, CA 94912). There are a number of things that should have made the game a stand-out. The sound effects, the visuals, the use of the famous click-command system, make this—technically speaking—the best Lucasfilm game so far, certainly on a par with *Maniac Mansion* and *Zak McKracken and the Alien Mindbenders*.

But there's a problem in the game. The action, the plot of the game, is repetitive, almost tedious.

It follows the film closely, but the bulk of the game action involves two major sequences . . . wandering the catacombs under the Venice Library and then in the Nazi castle/fortress.

The first maze-like challenge is entertaining enough, with skeletons and chambers filled with water, leading to the hidden tomb. But it reminded me rather too closely of Sierra-On-Line's, *Manhunter: New York* which featured an extended sewer-crawl.

But the Nazi fortress section seemed interminable (And this was with a rather complete guide as to what had to be done to find Indy's father.) There were a multitude of costume changes, fist-fights, and clomping around the much-too-large schloss. Long before you get to Berlin, and the dirigible, and the biplane, a lot of the enjoyment has gone out of the game.

Perhaps the film fettered the imagination of the designers too much. The technology was all there, but the fun of the gameplay seemed restrained by the film's plot. ■

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State of the Art

HOW TO BUILD A FUTURE

John Barnes

As *Analog* readers know, world-building is a prerequisite for good science fiction. But it isn't limited to easy things, like physics and astronomy. . . .

Building worlds mathematically is so basic to hard SF that we rarely think about *why* we do it.

I won't presume to say why anyone else does, but I do it because I have too little imagination.

Does that seem a shocking admission from a science fiction writer?

Think about what most fictional planets are like. The writer who doesn't world-build usually creates the familiar in drag: a single, excerpted environment. Jungle planets, ice planets, or desert worlds are usually just the Amazon, Antarctica, or the Kalahari without the research or detail a story actually set in those places requires.

Not merely limited in variety, they all seem to be the size of Chicago, or at best Georgia. Jerry Pournelle has aptly described this with the phrase "It was raining on Mongo that morning." Though SF writers claim to explore the wonder and vastness of the Universe, many forget that a planet is *big*. The Earth includes places as diverse as the Grand Canyon, the Black Sea, the Pacific atolls, Greenland, and the Mid-Atlantic Ridge. Yet how often are we told some planet is a "steamy jungle world" or a "polar waste?" (So what's the Earth—a "room temperature world with an oxygen-rich, water-saturated atmosphere?" Tell that to the poor tourist dropped off, wearing only his bathing suit, in the Whichaway Nunataks or Qattara Depression.)

Now compare those bastardized Earth environments with the wonderfully diverse created worlds of Poul Anderson, Larry Niven, or Hal Clement. I think it's exactly because those writers do calculations that they reach as far as they do. The calculations spur them to leap over the usual walls of imagination. The imagination must really stretch to take

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what the numbers say is plausible and see what that looks like standing on the ground. (The vivid picture Clement gives us of what it's like to *be* on Mesklin is what really makes that a classic piece of wordbuilding.)

IT WAS RAINING THAT CENTURY . . .

What's true of physical environments is true of social ones. How many versions of the Roman Empire, the high feudal period, or Tokugawa Japan, are there in SF? Just as many SF writers invent familiar environments, they also invent familiar history.

This does have the advantage that everything "goes together"—a 1st-century polity with a 1st-century economy and society automatically has some plausibility. (So do crocodile-like reptiles on jungle planets.)

Yet it cheats the reader of the excitement of going somewhere *really* new. How many Star Trek fans would argue that the "set-of-the-week club" episodes in the last year of the original series were as good as the earlier ones?

You also get the social equivalent of it raining on Mongo that morning. Just as we forget that there are a lot of very different places on a planet, we forget that a lot of different things happen in a century. When John D. Rockefeller was born, the last Revolutionary War veterans were still alive; when he died Neil Armstrong was seven years old. Thomas Jefferson lived through one-quarter of the nineteenth century, Thomas Edison more than half of it—that same century contained clipper-ship races, the experimental development of radio, the Romantic movement in music and literature, the birth of modern advertising, Greek Revival and Victorian Gothic, the canal era, Freud's early work, Lewis and Clark, Impressionism, the 1848 revolutions in Europe, the opening of Japan, and the first hints of atomic energy.

Yet many science-fictional future histories have less happening between now and 3000 than actually happened between 900 and 1200 A.D. Often, in SF, social change seems to have arrested anywhere from ten to fifty years after the present, technological change a century at most.

THE SAME SPUR FOR ANOTHER WALL

Just as doing the numbers can drive a planet-builder into realms of possibility he wouldn't otherwise enter, calculations that grow out of mathematical social science can help the society-builder envision the unprecedented.

I have a fairly extensive background for this (a math-heavy BA in economics and a math-methods-emphasis MA in political science) so my bag of tricks is bigger than will actually fit into any space reasonable for an *Analog* article. What I'm going to do now is take you along as I build a future, with some substantial commentary on why I'm making the choices I am and what other ones you might make. I'll only use a few tools from the kit, but this should at least give you some feel for what can be done.

Let me warn you that this is all just fun. With all respect to other writers (Flynn, 1987), I do not believe that the

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use of math methods in the social sciences will ever lead to social forecasting even on the level of pre-satellite weather forecasts. Sensitive dependence on initial conditions and measurement error are both intrinsically too extreme in social data for that. This stuff can be a good basis for stories, but if you get the feeling that you are forecasting the future, I suggest you lie down until it gets here.

STARTING FROM AN IDEA

I wanted to do a story about the introduction of instanteous travel (the transporter booth, if you like) into a civilization that had spanned several solar systems for centuries. Expansion and intensification of contacts between cultures has often caused spectacular events, so I was sure I could find plenty of excitement in such a world.

What kind of a future would FTL break into?

If you're going to write about a new way to do something, you first need some understanding of how it was done before. I arbitrarily decided to limit my pre-FTL starships, at least the colony-sized ones, to a velocity of one-half lightspeed—fast enough, with suspended animation limited to one century, to put many nearby stars within reach. At .5c, relativistic time dilation only slightly extends the human crew's range of travel. Additionally, limiting accelerations to 1.5 g maximum for any time more than a couple of days put the outer reachable limit for manned expeditions at about 40 light-years.

If I were doing a story about the exploration/colonization period, I'd need to do much more elaborate detail work, but with a non-scientist hero in a future where these technologies had been familiar for centuries, I could leave the suspended animation as a given, and needed only cursory work on the propulsion technology.

Again arbitrarily, I decided the starships would be photon rockets with a power-plant that converted mass to energy with perfect or near-perfect efficiency. Allowing for acceleration and deceleration in a one-way trip, a speed limit of .5c could be set by limiting the ratio of propellant mass to total mass to .75 maximum. Whether that limit is imposed by problems in handling antimatter, or the necessary size of the "field generators" (whatever they might be), or the tensile strength of Larry Niven's "balonium," doesn't matter because ship operation won't figure in the story, so again I left the problem for the physicists to play with.

FROM THE BUDGET FOR BALONIUM TO THE TEA CEREMONY

Assuming that interstellar colonization would be a relatively low priority for future civilization (important for prestige or PR, perhaps, but not truly vital), how long before colony ships would be cheap enough to represent little or no strain on the global budget? That would mark the beginning of a plausible colonization era.

Where physical worldbuilding uses equations, social worldbuilding generally must use models. A model, technically, is a "system state vector" (a

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set of numbers, like population, growth rate, GNP, economic growth, and per capita income, that characterizes the system at one moment in time [say 1989] plus a "transformation rule" for calculating a next vector in the same format ("multiply the growth rate by the population and add it to population to get new population," "divide GNP by population to get per capita income," etc.). By applying the transformation rule over and over, you can project a set of values indefinitely into the future.

To do modeling, I usually set up a spreadsheet (a columnar pad, for the rare *Analog* reader not yet computer-initiated). Each row is a system state vector, the values for one time period; each column is a social variable of interest. The cell formulas are the transformation rule. The values of social variables are calculated partly from present-day, and partly from lagged (previous period, next row up) values of other social variables. You simply record the initial state of the world in the first row, set up the cell formulas to calculate the next row, and then generate more rows until you reach the desired year. (If you're using pencil, calculator, and columnar pad, you'll be at it a *long* time—probably the major reason this wasn't done much before the early '80s. And be aware, if you're using a computer, that spreadsheet models tend to be huge—one I discuss below eventually took up about 600 kb of hard disk space.)

Initially I just wanted a quick-and-dirty estimate of the earliest quarter century in which a colony starship might reasonably depart Earth, so I set up my spreadsheet with one row equal to 25 years.

I started forward from 1985 with the following assumptions:

1. The fully loaded ship, exclusive of fuel, masses about 330 million kg. (60% of the size of the biggest present-day oil tankers). Dividing by 25% gives 1.33 billion kg of mass at launch, so one billion kg of fuel are required. (Regardless of destination because the ship travels ballistic most of the time.)

2. GWP (gross world product, the annual total value of all production and services worldwide) grows at a conservative 2.5% indefinitely. (This and other unattributed specific numbers are either found, or calculated from values found, in the 1989 *World Almanac*. There are better and more esoteric sources of numbers, but you can do just fine with that one simple source). Working in increments of 25 years, that's about 85% per iteration.

3. The starship is a government venture. As Earth continues to industrialize, the public/private mix, and the growth of the public sector, will tend to approximate those of the Western democracies of today.

(If you think that's a whopper of an assumption, you're right. Feel free to play around with drastically different values.)

Right now the average size of total government budget among Western democracies is about 37.9% of GDP (gross domestic product—GNP without foreign trade, to more accurately reflect the actual size of a national economy) and the public sector claims an additional

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7% per 25 years. (Heidenheimer, Heclo, and Adams, p. 173) We might simply figure a future date at which the government budget becomes 100% of GWP, but I chose to assume that the private sector is actually *losing 10% share* per 25 years. Thus the private sector dwindles but does not disappear (in fact it continues to grow in absolute terms—just more slowly than government).

4. The first colonizing starships will be built when one of them represents one half of one percent of five years of global government budgets. Modern nations rarely pursue non-vital projects of more than five years' duration, and one half of one percent of total government budget is about ⅔ the proportion of all federal, state, and local outlays going to NASA, and thus a conservative estimate of what the future civilization might find a sustainable funding level.

5. Fuel is the cost bottleneck. A century or more of unmanned or small-crew exploration has developed the necessary technology. This seems especially credible because the fuel converts to five million times present American annual energy production.

6. The price of energy remains constant. Energy price automatically sets a boundary on fuel price because the price of any fuel must lie between the price of the energy it will yield, and the price of the energy it takes to obtain it—below that range, none will be made; above, it will be too valuable to burn. I assumed starship fuel (antimatter or balonium) could be produced from electricity with perfect conversion, so it cost exactly what electricity did—good enough for the one-digit-or-so accuracy needed. For greater precision, I'd have had to specify a fuel-to-energy conversion efficiency and an energy consumption per unit fuel made, and calculated prices based on those.

Given a starship budget and a price of fuel, I just put a column for "starships per year" (annual starship budget divided by the price of 1 billion kg of fuel) on the modeling spreadsheet, and scanned down the sheet to see where it exceeded .2; that date plus five years would be a good figure for the first launch.

Unfortunately, with energy prices at present levels, launch year came to 3165. From past experience, that's much too far into the future to model at all, not to mention being extremely discouraging.

To get out of that situation, I added more balonium to the technology mix. I came up with the "Von Neumann powersat" or "VNP"—a space-borne electric power plant that puts out 50 trillion watts and reproduces itself every eight years. Whether VNPs are solar, nuclear, antimatter generators, or balonium transformers didn't matter to me any more than it usually matters to a mainstream author whether the electric power in his fictional house comes from hydro or coal. If it were relevant to the story, I'd simply work up some specific physical rationale to fit those economic parameters.

So this gave me a new Assumption 6, to replace the one above:

6. Sometime in the early 2000s the

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first VNP is constructed; within a few decades, their rapidly growing population is virtually the whole electric production for the solar system.

VNPs increase about eightfold every quarter century. GWP increases 1.85 fold in the same time. Demand for electricity is roughly a function of the square of national GNP, so presumably that means demand is going up $(1.85)^2 = 3.24$-fold per quarter century at the same time supply is increasing 8-fold.

In the very long run—and in 25 years you can modify machines, homes, practically anything—you can use an almost infinite amount of electricity if it's cheap enough. Assuming society holds growth in its electric bill at the same proportion of total expenditures, then, every 25 years the planet is buying 8 times as much electricity for 3.24 times as much money.

Or, to the one digit of accuracy we needed, the VNP causes price of electricity to halve every 25 years.

Under the new assumptions 2285 began the quarter century in which launching was feasible. Mankind's first interstellar colony would be launched in 2290.

Three centuries is still a very long way into the future—think back to 1690—and that's just the beginning of the colonization era. Since the idea I started out to work on pretty much demands that other solar systems have been colonized for some centuries, it takes a while to build and launch hundreds of starships, and it might take as much as 85 years travel time to some of the colonies, the date of the story is still further away from the present than any reasonable ability to extrapolate. (My experienced-based rule of thumb is that 500 years is the absolute maximum.)

I didn't want the world to get utterly unrecognizable (though that might make another good story), but clearly I would need a reason *why* it wasn't unrecognizable. I decided to add an event to the background: at or around the time the colony ships are leaving, for some reason or other, the global human culture decides change in general is bad, and begins the Inward Turn (a period like the Enlightenment or Renaissance). There will be much refinement but little new development after 2300 A.D.

Such things have happened. The familiar case is Tokugawa Japan, but China, Persia, and India have done similar things at times, and the tendency was clearly there in other cultures (e.g. Dark Ages Ireland, 4th century Rome). So it's a reasonable human possibility.

Of course, after several centuries of the tide running the *other* way in our culture, we're out of sympathy with such a cultural turning, and may think of it as "decadent," as "stagnation" and "degeneracy." But it need not be. The Inward Turn simply means people will value and explore one set of possibilities at the expense of another. It will tend to favor skills, arts, and crafts that require extensive refinement and disciplined training: gymnastics, martial arts, formal or classic styles in the arts, religions requiring elaborate meditative practices, taxonomic or "catalog" sciences, ethics and ontology in philosophy. By the same token, it will devalue

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that which requires novelty and personal passion: team contact sports, romanticism and subjectivism in arts, religions based on fervor and conversion experiences, theoretical sciences, epistemology. That's a choice—not a moral collapse. They'll have fewer Beethovens and Rimbauds, but more formal gardens and tea ceremonies.

And at the time of the story, centuries later, the Inward Turn will be as automatically accepted, unremarked, and beyond debate, as the Renaissance is today.

CYCLING FORWARD

What triggers the Inward Turn? We need to have some major event happen 300 years from now, give or take fifty. What could it be?

If I already had a clear picture of the society of 2285, I might simply make up a shock to impose. Since I don't, I'll develop the society first. Because good social models tend to be unstable, there may be a big enough shock occurring "naturally" near the desired date.

For this projection, I calculated annual values of the social variables, giving a more elaborate fine structure, because the social event I was looking for would lie somewhere in the rich detail of history. I'll discuss only the 7 variables that gave me a result I would use for the story, but I actually modeled more than 40 variables. (Like photographers, modelers have to shoot a lot more pictures than they keep.)

We'll start with the economy, taking Woodward and Bernstein's advice—as good in the social sciences as it is in investigative journalism—to "follow the money." It also happens to be a good example of cyclic phenomena.

The major cycles in economic growth are the Kondratiev (54 years), Kuznets (18.3 years), Hansen 1 (8.3 years), and Hansen 2 (3.5 years). The error bars on those times are so wide that you can arbitrarily flex values plus or minus 10%.

These are cycles in the rate of growth, not in the actual size of the economy itself. You can take growth in GWP as varying from 1% to about 6% annually (postwar values for industrial nations except for peculiar cases like Japan and Germany during postwar reconstruction) with the average at around 3.8%; or, taking data going much further back in history, you can assume annual economic growth can fluctuate between −3% and +9%, with an average of around 2.7%. I chose the smaller range.

The effect of each cycle is about 1.8 times as large as the effect of the next shortest—thus the Hansen 1 is 1.8 times as big, the Kuznets $1.8^2 = 3.24$ times as big, and the Kondratiev $1.8^3 = 5.83$ times as big as the Hansen 2.

I usually just use a sine wave with a period equal to the length of the cycle. First pick a year when the cycle "troughed"—went through a minimum. The year 1795 seems to have been the last 4-cycle trough, but all cycles except the Kondratiev seem to "reset" during very deep depressions, so you might arbitrarily pick three years during the 1930s for the Kuznets and Hansen troughs.

The trough will be one quarter cycle

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before the start of a new cycle, so you add one quarter of the period to that year, and now you have the zero year for that cycle. For the value of each cycle at all future dates, then:

Cycle value = sin ((Current date-zero year)/(Period/2π)).

Total cycle value = sum of all the cycles times their coefficients (those powers of 1.8).

Growth = average growth + k(total cycle value), where k is a normalizing constant, a simple fudge factor to make the results come out within the range of growth you've selected.

The value of GWP in year Y is then simply:

$GWP_Y = GWP_{Y-1}(1 + \text{growth rate})$.

As you can see in figure I, in the next three centuries the growth rate flexes all

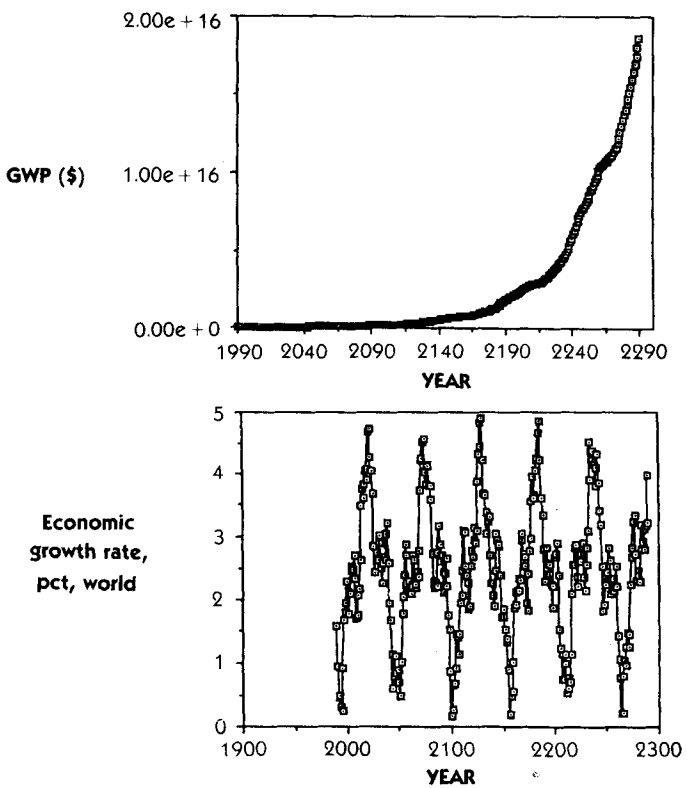

Figure I: Annual growth and GWP to the beginning of the Inward Turn.

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over the place, but in the long run of history what we see is simply the same explosive growth that has characterized the last century or so. By the time of the Inward Turn, everyone is a lot richer. But what is available for them to buy?

HALF MAGIC

I need not tell an SF audience that technological advance has dramatic effects. There are a lot of different ways to model it; this time I used the "shopping list" approach—gadgets are invented at a steady rate, but they are economically deployed (that is, come into actual widespread use) in bursts. Schumpeter suggested deployment might correlate with the upswing in the Kondratiev wave; it's also a truism that war brings rapid technical development.

To express this, I simply assume significant new inventions go onto a "shopping list" or "technological backlog" of potential technology, and move off the list and into real deployment at a rate that varies between 0 and 100%, depending on the Kondratiev cycle value and the values of warfare indicators (see below).

As you can see in figure II, this gives a fairly credible situation: technology sometimes stagnates as nothing new is deployed for a long time, and at other times skyrockets, especially after a long hiatus. This gave me as much information as I really wanted: eight major surges of technological innovation between now and the beginning of interstellar colonization. (A "major surge" is something on the order of the highly innovative periods 1900-20 or 1940-65.)

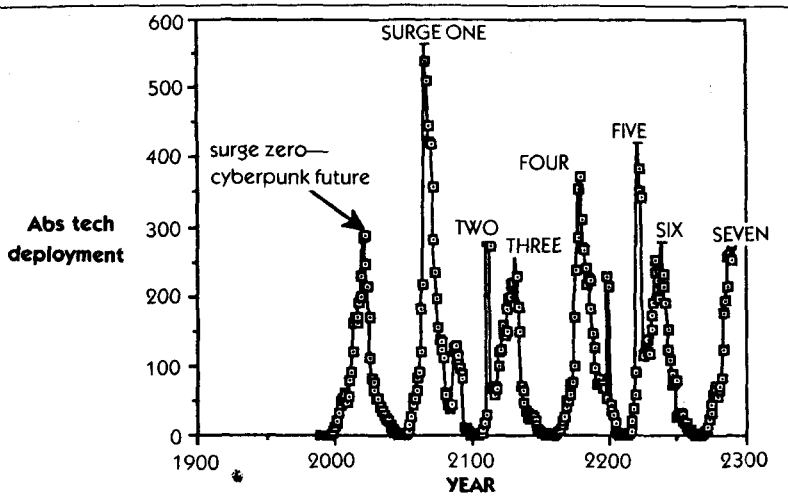

Figure II: Technology deployment (index of number of major innovations) annually 1990-2290.

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To envision the surges, I use a rule of thumb that has no justification other than gut feeling. Each new surge is 90% what you might have expected from the last one, plus 10% magic (in its Clarke's Law sense). So from the viewpoint of 1920, 90% of the gadgets of the (roughly) Manhattan Project through Apollo Project boom would be imaginable (indeed, some, like TV, were abortively available in the previous boom). But 10% (lasers, nuclear power, transistors) would be absolutely incomprehensible—magic.

I further arbitrarily assume that the major discoveries for the next surge have all been made as of today.

The graph shows a major surge in the 2000s and 2010s, Surge Zero, which should deploy everything in SF that seems pretty likely right now. *Everything.*

Does that feel like a real explosion in the brain, like Bruce Sterling or William Gibson at their dazzling best? All the same it's only the start.

Surge One must be an immense extension of everything in Surge Zero, *plus a 10% addition of things that work according to as-yet-undiscovered principles*. Surge Two must be extensions on everything (including the 10% of magic) plus 10% *new* magic. From our viewpoint it's now 19% magic.

And Surge Three . . . well, you see where this gets to. Since the Inward Turn starts at the end of Surge Seven, 52% of significant new technology in the culture we're imagining must be stuff we currently would not find comprehensible.

Realistically, the world should be half magic. Who'd have thought calculations, the lifeblood of hard SF, could drive us that far into fantasy?

THREE HUNDRED YEARS OF SEX AND VIOLENCE

Since we've already been through the business of setting up cycles, I'll just mention that there are 4 prominent cycles in the Index of International Battles, of lengths 142, 57, 22, and 11 years, in battles per year. (Any separable clash of armed forces between competing sovereignties is a "battle.")

The same cycles apply to "battle-days per year." Each day contains as many "battle-days" as it does battles—so that, for example, if 10 distinct battles go on for 10 days duration, that's 100 battle days.

Like the economic cycles, the longer the cycle the bigger its effect, but it's not quite so pronounced, and one-digit accuracy is about as far as I can comfortably go, so I suggest coefficients of 3, 2, 2, and 1 for those cycles.

Estimates on actual numbers of battle-days per year vary wildly; all sorts of international, defense, and peace organizations publish estimates, and no two are even remotely close to each other. (The problems include defining when a battle starts and stops, which incidents are big enough to be battles, and how separated things must be to be separate battles.) Thus there's no good guidance on what the numbers actually should be.

Once again flying by the seat of my pants, I simply estimated a range. In all

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of human history, I doubt there's been a day of peace—somewhere on the Earth, two military forces were probably fighting each other on every day of history. So an absolute minimum would be 400 battle-days per year (one-digit accuracy, again).

On the maximum side, the most battles probably occurred either during the 19th-century European colonial conquests or during World War II. There were eight major European colonial conquest powers, and most of them were fighting one insurrection or another most of the time. Add in the American Indian wars, and assume the larger British and French Empires were usually fighting two insurrections at once, and you get 11 battle-days/day.

In World War II, counting four Allied fronts against Japan and five against Germany/Italy, plus partisan activities in occupied areas, and counting each front as a battle-day every day, we get 11 battle-days/day.

Either way it comes to about 4,000 battle-days per year, which is obligingly one order of magnitude greater.

After about 1900, the percentage of global population killed in war per annum is an exponential function of the number of battle days. (This is just something I've found in playing with UN and various other statistics. It's purely do-it-yourself social science and comes with no institutional pedigrees, so if you don't like it please feel free to cook up your own).

Again, I set this up as a function that would flex between a minimum and a maximum. According to UN figures, in a very good year only about 1 in 100,000 people worldwide die of something directly war-related.

About the highest figure I can conceive (excluding genuine nuclear wars of annihilation so that there will be a future to write about) is that a 20-year war might kill half the global population. That's about an order of magnitude worse than World War II, which, if you extend it to include the SinoJapanese, Ethiopian, Spanish, and RussoFinnish wars leading into it and the many aftershock wars (Greece, Malaya, Korea, China, Ukraine, Palestine, etc.), killed around 5% of the global population between 1931 and 1952. So the global fatality rate varies between .00001% and 3.4% per annum, as an exponential function of battle-days.

Wars are allegedly about something or other. We aren't interested in every little brushfire conflict, of course, and neither will our descendants be—when was the last time you heard anyone refer to the War of the Pacific, Queen Anne's War, or Prusso-Danish War in passing, and expect you to follow the reference? But the two really heavy periods of fighting that appear in the 300 years should have some global significance.

In the theory of international competition, the classification "great power" comes up frequently. I like a modified version of Kennedy's definition: a great power is first, a nation that can, if it has the will, militarily enforce its wishes on any other nation not classified as a great power, and on credible alliances of non-great powers; and second, a nation which is able to make conquest by any

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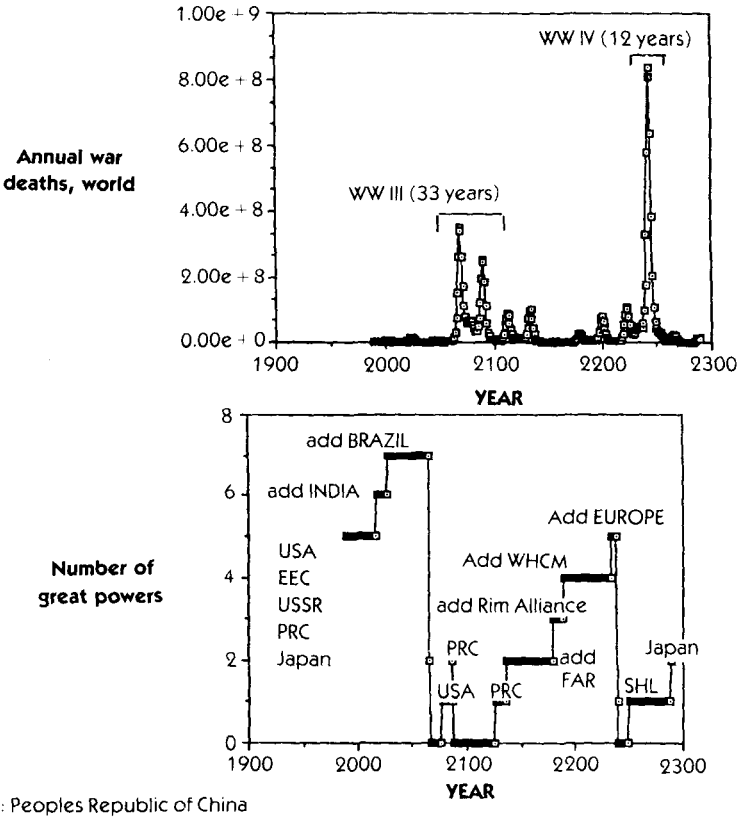
other great power too painful for the aggressor to contemplate.

If you apply those rules the way I do, there are five great powers in the world today: the USA, Japan, the USSR, China, and the European part of the NATO alliance.

Great powers come into being from sustained periods of economic growth. Major wars against other great powers produce very high death tolls and economically ruin great powers, busting them back to secondary status, sometimes permanently and often for decades.

The great powers normally get and

Figure III: War and the Great Powers to the Inward Turn.



PRC: Peoples Republic of China
FAR: Federated African Republics (subsaharan Africa)
WHCM: Western Hemisphere Common Mkt
SHL: Southern Hemisphere League

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consume the bulk of the world's wealth, so an ambitious secondary power needs a generation—25 years—of fast world growth to rise to great power status. Success for one rising power precludes anyone else's success. There are finitely many resources, power vacuums, and unclaimed turf in the world, and the secondary power that gets all or most of them is the one that becomes a great power—while shutting out everyone else, so I also allowed only one new great power to emerge per decade.

To express the way wars between great powers quickly knock them down the scale, I assumed that if annual global war deaths exceed 1%, twice their WWII value, all the great powers must be involved. I expressed this as a simple fraction—every time war deaths went over 1%, I busted ⅜ of the great powers (to the nearest integer) to secondary status. Thus a three or four year war at those historically unprecedented levels is enough to break all the great powers in the world.

The numbers of great powers, along with war deaths, are shown in figure III. There are two truly big wars in this future—World War III and IV, let us cleverly call them—and the starship launches come right when a second power manages to lurch up to Great Powerhood again. Normally that would be time for another war . . . so why not this time?

Let's look at population statistics. (This stage of the creative process approaches sex, like violence, in terms of its quantitative results, rather than its messy particulars).

How many people are there in 2290, and where do they live?

The results of the model can be seen in figure IV.

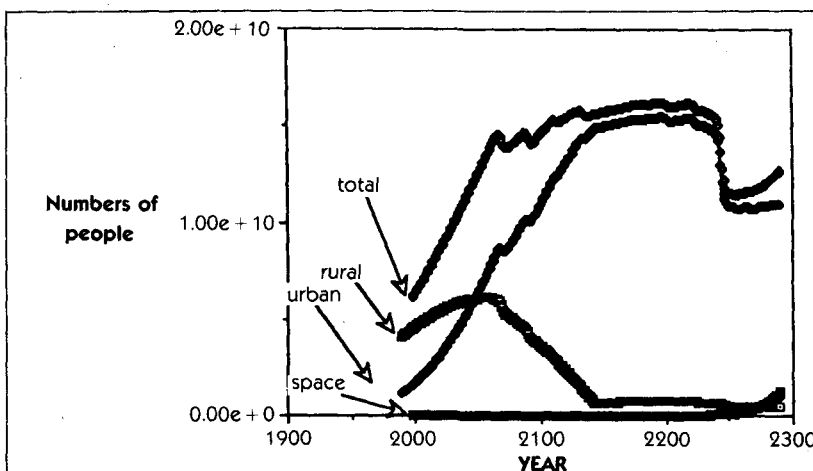

Figure IV: Solar System population, 1990-2290.

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Virtually all the growth of population in the long run comes from rural populations. This is caused by something that always startles elitists: people are not stupid. Agriculture is labor-intensive, and as long as an additional person can produce food in excess of its consumption, it pays to have another baby. (Famines are generally caused by a drastic change from the expected future—war, drought, or land confiscation changes the value of children after they're born). In most parts of the world, the expected value of children doesn't reach zero right out to the limit of human fertility.

By contrast, life in cities is expensive, and work children can do there less valuable, so having kids really doesn't pay. Thus over the long run (it takes time to alter perceptions, and peasants who move to the city don't suddenly de-acquire children), city dwellers will have children at or below a replacement rate and rural people will have all they can. "All they can" globally currently corresponds to a global rural population increase of about 2.3% per year.

Luckily, practically everyone would rather live in the city. (The American back-to-the-land fetish is an extreme minority taste.) Currently a bit under half of one percent of global population moves from country to city per year. If that continues, by 2056, the growth of rural areas has reversed, and as they decline in population the rate of population growth slows. In fact, World War IV is so big that global population actually peaks at around 15 billion in 2237 and declines to just under 11 billion by the beginning of the colonization era. Global population is then more than 95% urban (as opposed to 22% today).

For a quick extrapolation of spaceborne populations, assume a VNP makes work for 100 people and the percentage of spaceborne population that would be working in the energy industry declines steadily by 10% every 25 years. That gives a population growth rate of 6% (most of it supplied by immigration at first).

By the beginnings of interstellar colonization, there are 1.256 billion people living permanently in space. Go ahead and gasp—but it's a slower rate than the European population increase in Australia 1788 to 1900, and Australia effectively cost more to get to.

BEYOND MEGALO

Megalo- is the prefix for "real big." Hence the SF idea of "megalopolis," the giant city.

I won't report full details here—it's another article in its own right—but in playing around with statistics on the world's very largest cities, I've noticed there are roughly three groups: 1) New York and Tokyo. 2) Eight industrial centers with populations of 10 to 15 million. 3) About twenty Third World population jams.

They seem to group unusually clearly according to what I call a "respiration statistic"—how many dollars worth of goods per year must flow per unit perimeter to keep the city functioning. Tokyo and New York have respiration statistics about an order of magnitude

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greater than the eight giant industrial centers, which in turn have respiration statistics two orders of magnitude greater than the Third World giant cities. (The one interesting exception is that the respiration statistic for Osaka-Kobe-Kyoto (OKK) is about ⅕ that of New York or Tokyo, so it may be an intermediate case, or one in transition.)

It doesn't take a lot of travel to discover that the fundamental experience of living in these three kinds of places is drastically different, especially that categories 1 and 2 are different from category 3. So I set up a simple system to let categories 1 and 2 grow as population grew. Category 2 I call a "megalopolis"—similar in lifestyle and scale to LA, London, or Moscow today. Category 1, of which New York and Tokyo are the existing representatives, I dubbed a "hyperpolis."

And because in three centuries it didn't seem unreasonable to have at least one more kind come into being, I created the imaginary category of "transpolis" to cover a respiration statistic one order of magnitude greater than that of Category 1. This works out to a city of 100 million with a population per unit ground area like that of a modern high-rise apartment building. The technology to feed such a thing doesn't exist today, but I see no inherent impossibility.

I simply set up allocations so that some of the world's urbanizing population would flow into megalopoli, some megalopoli would grow into hyperpoli, and a very few hyperpoli would become transpoli. Which cities or areas became which, again, wasn't critical for the time in which I wanted to set my story, so I simply left it as a piece of cultural background to be filled in as necessary.

THE TIME OF THE INWARD TURN

In 2290 A.D., global population is steady at eleven billion, down 27% after World War IV, 41 years ago. Practically everyone lives in town, and about 17% of the population lives in giant high-density towns—the equivalent of 20th century LA or bigger. Half the technology is, by twentieth-century standards, magic. Global per capita income is about 110 times 1985 American per capita income. World War IV reduced transpoli from 7 to 5, and hyperpoli from 23 to 17, well within living memory. There are many veterans, former refugees, and survivors around, and the ruins of the destroyed hyperpoli and transpoli are still in existence, raw scars visible even from the cities on the moon, visited by grieving pilgrims as Auschwitz is today. In the last few years, the hegemony of one superpower has been challenged by the rise of another, and the fear of another war is in the air.

And that seems to me enough to explain the Inward Turn. At such a moment a charismatic leader might successfully move for an effective global sovereignty. The Earth becomes a loose federation, committed to develop internally, refining and integrating its culture, bringing technical, social, and political change to a near stop, letting humanity find time to knit together. (Again, that sounds unattractive to us—but we don't have four billion dead

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in a landscape of ruins, and a recent scare that it might happen again. People whose world was shattered only 40 years ago might feel very differently.)

If they take the Inward Turn, why would they launch colonies at all? Perhaps as a bribe—"your way of life must be assimilated here—but you can perpetuate it in the stars." Any group that can raise the money can launch something the size of a big 20th-century ship on a one-way trip to a preselected colony site on some other habitable planet. (I assume unmanned probes, and perhaps some manned scientific missions, have thoroughly scouted the feasible worlds).

Arbitrarily, I've set the colony ship size at 96 adults, one million preserved human embryos, plus everything needed to fully establish the colony. I also assume that because our descendants get better information faster, and perhaps have a better way of using it, there are no mistakes on the order of Jamestown or Botany Bay. (You could write a terrific story about such a mistake, though—remember these ships are much more strictly one-way.)

PLANETS WHOLESALE

The physics/astronomy/geology side of worldbuilding has been covered extensively and well elsewhere (see Gillett 1989 for a good update and reading list) so I won't deal with it here. When I need a lot of planets in a hurry, I set up a spreadsheet of the basic equations, one row to a planet. I put in randomizing factors that will keep planets within habitable zones and give acceptable mass, surface gravity, etc. In this case I used some real stars (G's, warmer K's, and cooler F's) within 40 light years of Sol, so the stellar information was a given and only the planets had to be generated.

For more colorful place names, I assigned habitable planets preferentially to stars that had individual names over stars with constellation names.

This is very unlikely to turn out to be the actual case.

Nearby stars that have individual names are almost invariably red giants, too old to have living worlds; several of the ones that aren't have white dwarf companions so that any living world there was cooked long ago. But for purposes of fiction and romance (and I hold few purposes higher), I preferred to use those star names. So I cooked up a hypothetical process that would cause practically all such stars to have, not living planets, but extremely easy to terraform planets—so easy, in fact, that robot equipment sent at near lightspeed would be able to have them "ready to move in" by the time the colony ships got there. Since the story itself was to be set only a few hundred years after terraformation, this immediately suggested all sorts of interesting local color that wouldn't have been there otherwise. Just such a dialog between calculation and art is what worldbuilding is all about.

The planet sheet can be as sophisticated as desire or skill can make it, but in practice you'll always end up doing a great deal of further work on each generated planet, drawing maps and so forth.

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This time, rather than use a random number table, or the supplied random number generator, for the six randomizing factors that went into each planet, I used the function $y_{n+1} = ky_n(1 - y_n)$, going down the columns of the spread sheet, with k in its chaotic range between 3 and 4, to make values cluster irregularly, creating just a few kinds of planets plus a few weird outliers.

I did that for several reasons. It fit my basic feeling that the universe is made up of endless variations on just a few themes. There aren't an infinite number of kinds of stars, the gas giant planets we know are all clearly of the same family, and there are just a few common kinds of ecosystem on land on the Earth . . . so why not just a few common kinds of habitable planet, plus occasional "Australias" and "Galapagoses"?

It also created an interesting potential situation in interstellar trade, because the more alike two places are the less they have to trade and the more they compete with each other. If there are just a few types, then most planets will have several serious trade rivals and a finite number of good markets.

Finally, there's only room for a finite number of symbols in any story or collection of stories, and if you intend that the environment mean something, contrasts will work better esthetically if they're to a small number of alternatives (Arrakis v. Caladan for example). You need enough "normal" planets to establish that one in particular is "weird."

This time my generator gave me three basic categories of planet:

*Six "Wet Mars" planets, smaller and cooler than Earth with big oceans and just scatterings of volcanic islands and some Greenland or New Guinea sized pieces of continental rock. Colonies tend to huddle in their tropics.

*Fourteen "Utah" planets, worlds 5-15% larger than Earth with much more extensive continents and 10-35% of their areas covered with dense briny seas (mostly long and narrow like the Red, Mediterranean, or Timor Sea), intense insolation, and high axial tilts. A lot of their surface area is fantastically hostile—deserts drier than the Atacama, enormous daily and seasonal temperature swings, mountain ranges that dwarf the Himalayas—but seacoasts are habitable well into arctic latitudes.

*Eight "Cold Indonesia" planets —Earthlike but cooler, with bigger polar caps, and somewhat less land area broken into many smaller pieces. The tropics and lower temperate zones are pleasant.

In addition to these, the sheet also generated five outliers, mixed or peculiar cases that added variety.

WHEN DO WE GET WHERE?

With the set of destinations worked out, the next question was timing of colony arrivals. Obviously that depended on when they were launched.

The simplest assumption is that since economic growth continues, if we leave the starship budget at a fixed 5/100 of global government budget, starships will be launched at a rate proportional to cumulative economic growth. There were 33 habitable planets in 25 solar

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systems, presumably all well surveyed. Knowing what is available, what does the world government do?

Trying to think like hypothetical bureaucrats under the circumstances, it seems to me that a system whose overriding concerns are peace and stability would want, first of all, to insure that there was as little basis as possible for rivalries between colonies on any one planet, and that there were no "wild" or "open" frontier worlds out there where dissidents or malcontents might build up strength in isolation. There's going to be a lot of looseness for cultural development, but you don't want to create, or leave, a space for an actual enemy to exist in. In fact, if you're trying to keep social change slow, you don't want anywhere out there undergoing uncontrolled growth—you risk creating a potential Commodore Perry in a few centuries, and a culture that thinks like this one thinks in terms of millennia.

So clearly, to avoid having untended open real estate anywhere, the first priority is to get *some* colony down in every system, and then on every planet. The first 25 colonies go one to a solar system, and the next 8 go to empty planets in solar systems that have more than one habitable world.

To insure equality, you make sure nobody has to live in the truly nasty parts of the planet. Every colony is granted an area with area, resources, and worst-case climate comparable to France, Texas, or the Ukraine. In the whole set of habitable worlds, 1,240 such spaces were available, ⅘ of them on the 14 Utah-type planets. (For comparison, the sheet gives a value of 46 such spaces for Earth).

For political stability, you want most of the colonies on any one planet to be close together in age—as we'll see, these colonies grow so fast that in a century or two they might well start grabbing land assigned to somebody else. So you want the last colony to land within 100 years of the first colony's arrival.

Thus after the "elder" colonies are planted on each planet—three planets don't have good spaces for more than one—you "fill up" each planet rapidly with younger colonies. That way the younger colonies will all be close together in age, and can, if necessary, support each other against the larger elder colonies.

Obviously the fewer colonies assigned to a planet, the faster it can be filled up, especially in the early years when you're still not launching many ships per year. So each successive colonizing mission goes to whichever planet has the *fewest* open slots.

Knowing ships per year launched, order of colonization, and traveltime, working up founding dates of every colony is no harder than coming up with a simple bus schedule. The first colony, on a Utah planet circling Alpha Centauri, is planted in 2299; the last colony arrives at another Utah planet, this one circling Theta Ursa Major, in 2475, having left Earth in 2390. (Coincidentally, exactly 100 years after the first colony left).

With those missions, the "colonization era" is over. Colony ships can't

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reach any more systems from Earth, and none of the colonized systems is as yet ready to launch a secondary colony. Of course colonies could be sent out from Earth to be refueled in distant systems, but remember that this is a century after the Inward Turn began—the interest in reaching out may have dwindled. So the colonies get planted, and grow, and time goes by . . .

THE NUCLEAR FAMILY: TEN FROM THE WOMB, THIRTY FROM THE VAT

I gave each ship 48 couples of childbearing age and one million frozen embryos. What would that grow into?

This required only a very rough demographic model, because I just wanted to know what the population age profile and size would look like, and from past experience I knew that a "point entry" demographic model would give me the two digits of accuracy needed.

The quick-and-dirty spreadsheet I created is thus extremely crude. A point entry model is one in which all the major demographic life changes are assumed to happen simultaneously for everyone. So in this model:

1. The ship arrives on the 19th birthday of all 96 adults.

2. Exactly one year later, on their 20th birthdays, each of the 48 couples adds a decanted baby (a former frozen embryo) to the family. In addition, one-third of the mothers give birth on their 20th birthday.

3. Every birthday thereafter, through the 49th, all adult couples adopt a decanted baby (until the supply runs out) and one-third of them have an additional birth.

4. All children pair off into couples on their 19th birthdays and are part of the reproductive pool beginning with their 20th birthdays.

5. Everyone drops dead on his or her 80th birthday.

No doubt Lewis Carroll could have a lot of fun with such a society. One can imagine Big Day celebrations every January first, in which the whole family gets together to unbottle a new crowd of babies in the morning, attends a mass wedding at lunch followed by a mass birthing, and then goes out to the cemetery to watch the old people drop into their predug graves before going home to the traditional dinner.

Yet although the results this model yields are different from the real world, for the story I want to tell, 400 years after landing, they aren't different enough to matter. The demographic profiles for two planets (size of cohort by age) are shown in figure V.

If you need a more accurate model (e.g., to get accurate effects of baby booms, plagues, or wars in the age profile), you can always improve the precision by cutting down the time represented by one iteration, making deaths or births depend on variable fractions of many age cohorts, and installing more leaks (bachelorhood, early death, individual preference, sterility) into the reproductive pool.

Just one warning—if you do try a more elaborate model, make sure that the total death fractions applied to each cohort add up to 1, as do the total fractions moved out of the reproductive

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pool. Few things screw up a demographic profile as thoroughly as immortality, negative people, perpetually fertile dead people, or reverse mothers!

By prior assumption, these would be planets without significant technology gains or wars, so I didn't put those cycles into the process. You could probably do interesting things with diffusing technology via radio from multiple points, and the shopping list model might be very interesting for that, but

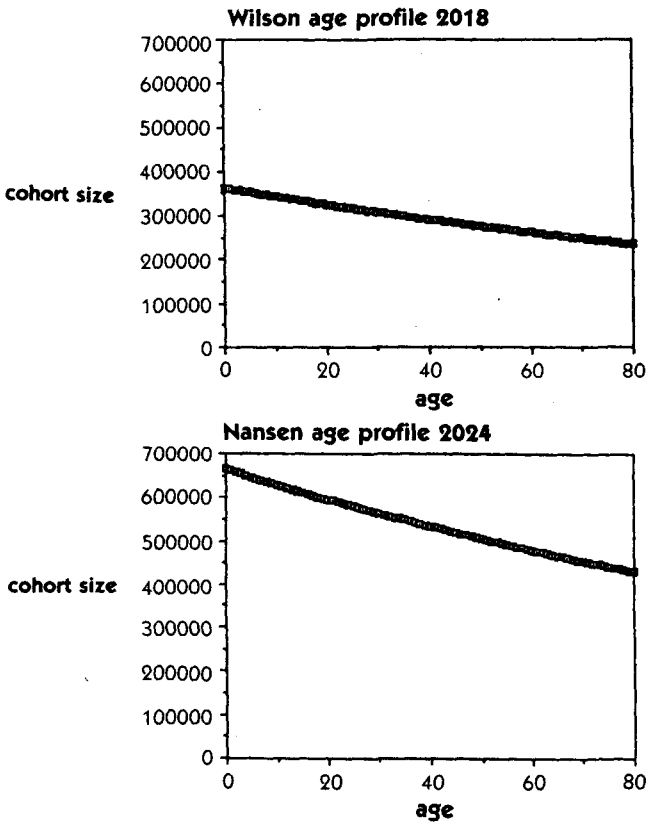

Figure V: Age profiles for Wilson and Nansen at the time they get instantaneous travel.

Wilson was colonized some decades prior to Nansen—notice that the downward slope of the profile is less acute. The downward slope indicates a growing (hence youthening) population.

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again, that's another story.

For the economic cycles, I suggest starting the Kondratiev wave with its minimum value on the landing date, the Kuznets cycle whenever you think they'd start putting up buildings, the Hansen 1 cycle at the point where they'd be setting up factories, and the Hansen 2 cycle whenever they'd start making their own goods rather than living on what came in the ship, because the three shorter cycles are traditionally identified with building, physical capital, and inventory investment.

THE STUDENT EXCHANGE ECONOMY

Before the introduction of FTL, is there anything to trade between planets?

It is a basic principle of transportation economics that, if there's a faster way to get it for the same price, the slower way won't be there at all.

First of all, since a radio transmission can carry instructions on how to make certain goods and gets there in half the time of a ship carrying the goods, given the speed of construction possible with self-replication, it's very hard to see how any finished goods could be involved in trade. Designs will probably travel by radio, and thus money and information might flow between star systems, but cargoes of finished goods won't.

Given the quantities of energy available at the very low prices that make colonization possible at all (presumably every colonized solar system has VNP's), it's equally hard to see what raw materials could be in short enough supply to be a problem. With 50% magic technology, even if somehow you had a whole solar system with none of some vital element, I would guess transmutation would be cheaper than transportation.

Works of art can also go by radio, even paintings, sculptures, and dances if the recordings are precise enough holograms. Scientific papers are no problem either, though biological specimens might have to go by ship. Again, though, with our 50% magic technology, it's more likely that a full genetic description would be sent by radio, and the lifeform of interest "constructed" on site, and if the technology base also includes really sophisticated computer simulations, rather than doing the traditional random searches for interesting pharmacological materials, biochemical engineers will be constructing specific molecules for specific receptor sites. In that case no one will be interested in exobiotes for potential new drugs or spices—which have traditionally been high-priced low-shipping-cost goods, and hence great openers of trade routes.

Are we left with nothing but one-way tourism?

Well, almost. Although all kinds of information comes in via radio from 33 other worlds, the big problem is that it gets increasingly hard to understand. Other cultures diverge from your own, and it can take up to 85 years to get an answer to a question.

Ideally you want someone to talk to about it who won't take decades to reply. So maybe you get the equivalent of interstellar Fulbright scholars, stu-

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dents on life-abroad programs. They might serve as "interpreters" for data from their home system and perhaps from those beyond it (from the standpoint of their adopted system).

They probably do *not* spend all their travel time in suspended animation; instead, they put a lot of time into reading and viewing transmissions from back home and from their destination, so that they'll be fluent in the culture they left (though behind it) and fairly fluent in the one they're joining—thus making good interpreters for some decades afterwards.

On the other hand, the older they are, the less useful life is left in them—so perhaps they spend half their time in the tank. Further, since we've established that suspended animation is risky (remember, after 100 years, odds are you're dead—which is why the ships can't get much further than their 40 light-year limit), a few of them probably die on the way.

Well, then who will go? You can hardly send condemned criminals (usually not the academic type), dissidents (not representative), or desperate poor people (probably no poor people—living standards are likely to be as high as Earth's in short order).

Probably most of them will be self-selected. In a population of millions, you can surely find one hundred or so acceptable people who will have personal reasons for taking a one-way trip to somewhere else entirely, especially if the "somewhere else" is a place where they'll be in a very high-prestige, high-authority position. They will have five major characteristics—they'll be:

1) young enough to be worth sending,

2) smart enough to be able to enjoy the years of study aboard ship,

3) socialized enough to be endurable company for everyone else on board, and

4) abjectly miserable enough in their home culture to leave it forever, but

5) not actually incapable of happiness (if they were, they'd stay home and kill themselves).

100 such people confined in a small space for several years . . . that sounds like a story to me. It's still not the one I'm writing, however.

THE NETWORK IN THE STARS

To do this next step, you need to do enough simple trigonometry to figure out how far apart the stars all are. This gives you a "distance matrix," not unlike the mileage charts found in road atlases. Then, given the known performance of the starships, it's fairly trivial to convert the distance matrix to a travel time matrix.

Assuming we don't want people to spend more than 15 years out of suspended animation (too much aging, since they must leave as educated adults and arrive with some decades of vigorous health still ahead of them), and that they need to spend about half their time awake to keep track of the cultures they're moving between, the practical travel time is about 30-35 years. Planets will exchange only within that radius, *unless* there are no closer neighbors with which to exchange. In that case, a planet

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will exchange with its closest neighbor, paying enormous premiums, plus any other planet that is insignificantly further away than that (say less than 10% greater travel time).

The acceptable routes by these rules are shown in the "route map," map 1. It shows the major trade routes (those that make economic sense) and the secondary trade routes (those within a few percent of making sense, plus the routes to the nearest neighbors for those planets that don't have any choice in the matter).

GETTING DOWN TO CASES

The map immediately drew my attention to the Mufrid and Arcturus systems. Though they exchange easily among themselves, they're quite remote from the hub. That combination of close relationship with each other and being a long way away from the rest of Human Space suggests really deviant subcultures could grow there, more so because there are only two colonies in the Mufrid system and one in the Arcturus—fewer elements in the mix means it will be less homogenized. Cultures there can be both very archaic (i.e., comprehensible to my 20th-century readers) and truly bizarre to the rest of Human Space. If I chose a protagonist from there, when the transporter booth was invented, I would have a good pair of eyes to go see 29th-century Human Space through.

I set up a convention to avoid having to do too much thinking about names: habitable planets are named, in order of distance from Earth, after winners of the Nobel Peace Prize, beginning with the oldest. So Alpha Centauri's habitable planets are Dunant and Passy, Arcturus's is Wilson, and Mufrid's is Nansen.

Circling Mufrid, Nansen has good spaces for only two colonies. This world, one of the five "outliers" (fitting none of the three classifications) is cold, wet, and heavy—oceans almost saturated with salt, just to keep it from freezing (and even then I had to add a great deal of calcium chloride in solution as well), gravity 1.2 Earth's, Antarctic conditions on small continents in its temperate zones, continent-sized rafts of polar ice on which CO_2 snow falls every winter. But at the equator, there are a few islands with year-round weather not too different from that of Seattle in the winter—rainy and cold and nasty, but humanly bearable.

Around Arcturus, a mere 6.5 light years away from Mufrid but some 25 light-years from Earth, Wilson is a Cold Indonesia planet with just one habitable area—an island about the size of Borneo with the climate of Auckland, New Zealand. (There would be room for many more colonies except that Wilson is almost devoid of land around the equator). Besides the one large equatorial island, there are two polar continents, plus many Greenland-like islands in the temperate zones. Arcturus is much more massive and puts out more heat than Sol, but Wilson orbits so far away it gets only about half the insolation Earth does (much more of it is infrared, though—it's dim but warm). As a result, Wilson circles Arcturus at a distance of 7 AU, with a year of about 12 Earth-years.

Given its steep axial tilt, I created the following deliberately weird ecology for

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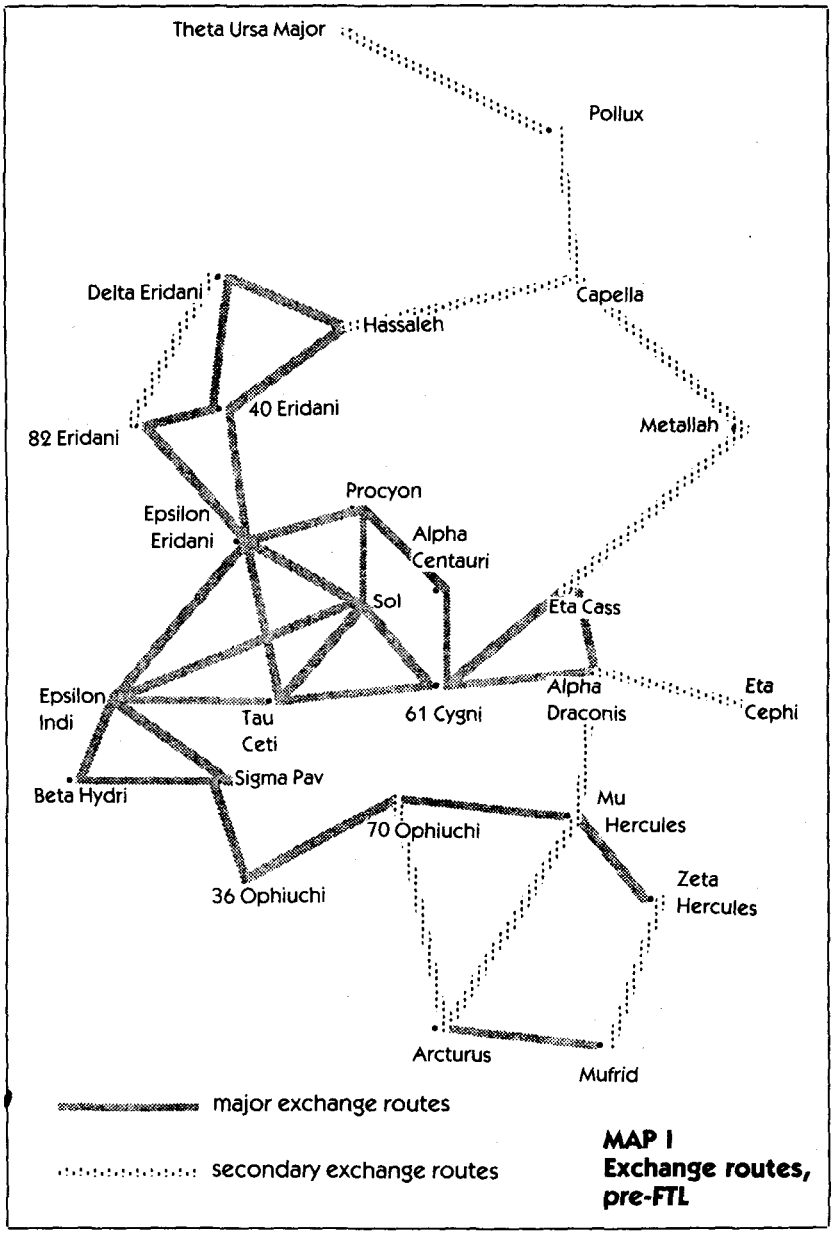

MAP 1
Exchange routes, pre-FTL

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it: continental ice forms on the dark pole every winter but melts completely every summer, watering very fast-growing vegetation. Every fall the whole continent burns down. (This image may have to do with my having spent the last few years in Montana.)

The soot from the burning produces more rapid cooling in the fall hemisphere, but it also darkens the ice in the other hemisphere, thus accelerating the melt and hastening the warming there.

The result is that temperature differences between the hemispheres are large, and they reverse very rapidly. That's a formula for violent weather, so the folks in the single colony have to look out for good-sized hurricanes as a regular thing, a brief "nuclear fall" every six Terran years, and, about three years after each nuclear fall, spectacular hurricanes on a scale never seen on Earth.

On the other hand, between those, the weather's extremely nice, and the surfing is probably terrific. People might do a lot of hiking and camping on the continents or the other islands during their summer.

Now—what if we amplified the contrast between those two worlds by setting up cultures that differed drastically emotionally and psychologically? Suppose, for example, the icy, cloudy tropics of Nansen got a couple of dour, stern, puritanical groups ("we are not in this world for a good time"), and the warm sunny island on Wilson got a bunch of free-spirited, fun-loving romantics ("let the good times roll!")? You might think of it as an exaggerated version of the difference between traditional New Hampshire and traditional New Orleans.

Now, what if someone who had long ago fled from one of Nansen's constricted, cold colonies for the warm tolerance of Wilson—had the chance to go back instantaneously?

Perhaps it sounds like he'd have to be crazy, but maybe there is something he really must do. And when people really have to do something they don't want to—there's the start of a story.

In developing that story, there's a whole other realm of economic and social models to be tackled—the dynamic/chaotic models that can generate a month by month picture of what happens on each planet the day after they turn on the transporter booth. Those are interesting too, but space doesn't allow tackling them this time out.

And somewhere along the way, of course, I still do have to write that story. ■

SUGGESTED SOURCES AND NIFTY READING:
A Loose Guide to Finding More Good Tricks

Anderson, Poul. "How to Build a Planet." *SFWA Handbook*, 1976. Still the best short compendium of the most basic equations for physical worldbuilding.

Beenstock, Michael R. *The World Economy in Transition*. Technical; a lot of good data.

Dewey, Edward R. *Cycles*. Out of print. Dewey's theories of the origins of cycles are mystical, and grossly out of date in the light of chaos theory,

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and he reports the coincidental and the ludicrous side by side with the well established, but there's much that's useful as well. Second edition edited by Og Mandino is even less accurate and useful.

Dunnigan, James F. *How to Make War*. Morrow: New York 1983. All the basic information you'd need for near future military simulations.

Flynn, Michael F. "An Introduction to Psychohistory," Parts I and II, *Analog*, April and May 1988. Good coverage of many different regularities in social phenomena.

Gillett, Stephen L. "On Building an Earth-Like Planet." *Analog* July 1989. Readable discussion of physical worldbuilding, plus a solid bibliography.

Goldstein, Joshua, S. "Kondratieff Waves as War Cycles." *International Studies Quarterly*, Spring 1985. Highly technical exploration of possible coupling. Some excellent tables of data.

Heidenheimer, Arnold J., Hugh Heclo, and Carolyn Teich Adams. *Comparative Public Policy: The Politics of Social Choice in Europe and America. (2nd ed)*. St. Martin's: New York 1983. Many tables of interesting social data hard to find anywhere else. Also an excellent guide to what modern governments actually do and how they actually do it; a good antidote to some of what you'll find in SF.

Kennedy, Paul. *The Rise and Fall of the Great Powers*. Random: New York 1987. An excellent, highly readable discussion of many of the basic issues from a historical perspective.

Modelski, George. *Principles of World Politics* and *Long Cycles in World Politics*. The basic texts on cyclic phenomena in international power relations. Highly technical. Good data.

Overseas Development Council. *The U.S. and World Development: Agenda for Action*. New York: Praeger. Published annually. The statistical appendix is invaluable.

Rosecrance, Richard. "Long Cycle Theory and International Relations," *International Organization* Spring 1987. Review article on current issues in the field.

Samuelson, Paul A. *Economics*. McGraw Hill: New York. So many editions it's hard to keep up, but anything from about the 10th (1976) forward should be fairly accurate. In my opinion, one of the best textbooks ever written on any subject.

Sundquist, James. *Dynamics of the Party System*. Brookings: Washington 1973. The fundamental text on party realignment, the basic dynamic of American political change.

van Duijn, J.J. *The Long Wave in Economic Life*. Probably the closest thing to a classic in cyclic theory.

World Almanac. Pharos: New York. Published annually. There's no disgrace in using it; data you get here are usually reliable. Excellent for browsing for ideas if you're doing any statistical work yourself.

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the reference library

By Tom Easton

The Argus Gambit: The Dreamers of the Day, Book One, David D. Ross, St. Martin's, $18.95, 368 pp.
Grass, Sheri S. Tepper, Foundation/ Doubleday, $18.95, 336 pp.
Megalomania, Ian Wallace, DAW, $3.75, 179 pp.
The City in the Autumn Stars, Michael Moorcock, Ace, $4.50, 357 pp.
The Fortress of the Pearl, Michael Moorcock, Ace, $16.95, 240 pp.
War Birds, R. M. Meluch, Signet/NAL, $3.95, 254 pp.
Men from Earth, Buzz Aldrin and Malcolm McConnell, Bantam, $19.95, 314 + xxii pp.

Last September, I reviewed Rob Chilson's *Men Like Rats*, saying that it seemed a clear extension of another novel I had read long ago. I presumed that Chilson was responsible for that predecessor.

I was wrong. Chilson wrote me to say, "I've written nothing else on this subject . . . You may be thtinking of something I don't know about . . ." In addition, a reader—who prefers that his name not be published in this connection—wrote to identify the predecessor as William Tenn's *Of Men and Monsters* (Ballantine, 1968), of which "The Men in the Walls" (*Galaxy*, 1963) was an earlier, shorter version. Said reader then proceeded to grumble about plagiarism. Other reviewers (e.g., Dean Lambe, in *Lan's Lantern* #30) have been saying similar things.

Is Chilson guilty of plagiarism? The dictionary says plagiarism is passing off as one's own "the ideas, words, or writings" of another. It does not say that failing to distinguish between a memory and an original thought, which Chilson may have done, is an acceptable excuse. But we don't usually get upset about it unless the plagiarist is lifting whole sentences, paragraphs, or more. Ideas? In fiction, at least, they can't be

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monopolized. If we bar writers from using ideas that have been used before, whether or not the writers recall the sources, the bookstores would have much less stock to sell you. Just think of the plague of medievaloid fantasies, imitations of Tolkien, T. H. White, and each other. Think of all the conanisms, alien invasions, star wars, and bloody horror novels differing only in their particular bogeymen.

Is it ever really legitimate to use another's ideas? Of course, if those ideas have been swiped so often that they have become public property—or clichés. Or if one can express them better, analyze them, argue with them, or take them further than did their originator. The last of those alternatives is what Chilson did. But it would have been both courteous and honorable to recognize his debt to Tenn (if he was aware of it). That is what acknowledgements pages are for.

If it were easy to be original, we wouldn't value originality as much as we do. On the other hand, if it were easy to be original, most of the books I review and you buy would be much better.

This is, I suppose, the fundamental problem with David D. Ross' **The Argus Gambit: The Dreamers of the Day, Book One**. Ross is a skillful enough storyteller. But he is less original than he should be: The ideas about which he writes are not entirely his own.

The "dreamers" of the series title are those politicians, entrepreneurs, scientists, and engineers who push the envelope of human progress. They are opposed by those who favor retreat—fanatic Greens who terrorize pedestrians carrying newspapers on the grounds that they are responsible for despoiling the environment (trees die to make paper); "Jasons" who attack those who use drugs or have abortions; labor partisans so alarmed at the way technological progress makes old jobs obsolete (never mind that it creates new ones) that they ban new patents and products); politicians so afraid of international competition and foreign pollution of America's national purity that they put a wall of guns and missiles around North and South America.

In Ross' novel, history sits on a cusp. Everywhere except in the Americas, war and rebellion have despoiled civilization, while populations have continued to boom. The USSR is now dominated by the Genetic Communists, who believe that genetic engineering will permit the perfection of the Communist citizen. Food supplies are marginal. And a viral plague is destroying cereal crops in South America. The world needs help.

Fortunately, the US is changing. A new president is about to take office. And a dead scientist supposedly created a scheme—the Strubeck Equations—for artificial photosynthesis that just might permit the creation of plentiful new food supplies. Dr. Dorian Nye goes to Europe to confer on the crisis. On his return, he is shot. Or is he? The corpse is not him, but a British actor. His bodyguard, Mel Hardrim, in disgrace for his failure, begins to search for the truth. Meanwhile, a member of the team studying the crop plague comes to the conclusion that it was genetically engineered. His findings are squelched. He sneaks back to the US, where he eventually comes to Hardrim's attention. Hardrim learns of the Argus Society, whose membership includes the nation's greatest scientists. Dorian Nye reappears, with the solution to the Strubeck Equations, which will require the strengthening of the space program in order to put a food factory near the sun.

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The new president forces a food aid program down the throats of the industrialized nations. And Hardrim learns what the Argus Society is all about—the cultivation of genius, the creation of circumstances in which that genius must be unleashed to shine, the salvation of civilization and humanity.

One of the three geniuses seeded into society by the Argus Society is the quintessential capitalist-engineer. He is Ross' savior, and if his shining virtue suggests that his prototype was created by Ayn Rand, well, Ross does give an explicit nod to *Atlas Shrugged*. As I recall Rand's book, however, her characters were somewhat more believable. Yes, her heroes were also impossibly noble. But her villains may have been less self-consciously evil, more the products of their situations. Ross' villains glory in their evil like the villains of old-time melodramas. For all the care Ross has put into his creation, he therefore forfeits a measure of believability.

The basic idea Ross "borrows" (albeit with acknowledgement) is Rand's. Does he handle it any better? In some ways, yes, for the world he portrays is one closer to modern readers. He also recognizes that Rand's solution was too simplistic. But in some ways, no. The characters are just too clearly off the shelf.

In addition, he is unable to escape the need to give his characters the sort of rubber ethics that make suspect even the heroes' integrity. He would have done better to promote a purer ethics, perhaps the ethics of sheer survival, or of humanity's manifest destiny, or even of Niven's and Pournelle's "evolution in action" (*Oath of Fealty*).

Sheri S. Tepper's **Grass** is a far, far better thing. It may, in fact, be the best thing she had done to date. Certainly, it will be a contender for major awards.

In this book's future, the Mormons have risen to dominate civilization as "the Saints." The society they rule, centered on Earth but covering a number of worlds, is "Sanctity," and its basic public premise is that if your name and a tissue sample are saved in Sanctity's machinery, you will live forever. Unfortunately, there is a plague that is killing people everywhere except on the world of Grass, where nearly all vegetation is grass and whose inhabitants refuse both to admit Sanctity's missionaries and to permit scientists to study their world to learn why it is free of plague.

Enter the Old Catholic Yrarier family—father Rigo, mother Marjorie Westriding, adolescents Tony and Stella. They are horse people, chosen as ambassadors because the Grassian aristocracy have an obsession with something that sounds a lot like foxhunting. When they arrive, however, they find that the local Hunt, though it uses familiar terms—Mounts, Hounds, Fox—is something else again. The Hounds are the size of horses, the Mounts bigger yet, and both resemble nothing more than spiny carnosaurs. And it is these local creatures that seem to dictate the terms and occasions of the Hunt.

Add to the mystery the ruins of an Arbai city. Similar ruins are on many worlds, but elsewhere they are empty, as if their residents had succumbed to a plague (of course). Here they are festooned with mummified corpses.

This is enough to give the astute reader a good idea of what is going on, but even the most astute readers of all will not be able to predict everything that Tepper has up her sleeve. Nor, for that matter, is mere plot all that is going on at all, at all. Marjorie Westriding

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Yrarier is a woman burdened by past, present, and religion. She is subservient to both husband and priests, riddled with guilt for her wishes for a life, a competence, a destiny of her own, paralyzed by the passivity induced by an autocratic morality. And her problems, her discovery of self and empowerment, play beautifully against the similar problems, discoveries, and empowerments of Grass' alien natives.

Grass is a tale of the relative values of rigidity and flexibility, of obsession and compromise, of . . . I could go on. The sheer richness of Tepper's imagination invites the reviewer to tell more and more—for instance, about the fascinating towers of the Friary, what happens there, and how they reflect and comment upon Sanctity's headquarters; or about the intricate (and probably overdone) relationships between Hound, Mount, and Fox—but I won't. I'll let you discover this story's many levels for yourself, and I promise you'll enjoy the process.

I haven't been following Ian Wallace's work very closely. Having just picked up and read his latest, **Megalomania**, I find that it's just as well.

Wallace paints a Sol Galaxy (actually a mere 54 planets) managed from Earth by a corporation under contract to the government. The head of the corporation is Croyd, a superhero type who can jump about at will in space, time, and other people's heads. Croyd's protege, Dino Trigg, has come to feel that he should run the show. Toward that end, Trigg uses his Croyd-taught mental powers to force board members to vote for him. Unfortunately, Croyd twigs to the plot and releases from his body (somehow) a substance that counteracts Trigg's influence. Angry, Trigg vows revenge by going back in time two billion years to use a relatively small cyclotron, controlled by music developed from the nucleotide sequences of his own genes, to cause the Magellanic Clouds to coalesce and aim a galactic jet toward, and thus destroy, Sol Galaxy.

The tale has its points, but logic isn't one of them. Why should the music make any difference? Duntesk. Given Croyd's superpowers, and the ease with which he eventually defeats Trigg, why did Croyd ever let Trigg get started on his rebellion, and then on his dastardly plot? Duntesk. What is the new Math that makes the volume of a sphere with a radius of 800,000 light-years a mere 25,000,000 cubic light-years?[1] Duntesk. What is the resemblance of such constructions as "For seated-next-to-him Croyd . . ." and "a toward-them-open, daised counter-parenthesis" to normal, grammatical English? They're clear enough, but still, duntesk.

I have a feeling Wallace is trying to be E. E. "Doc" Smith. He's got the super-science, super-heroes, and super-villains. He's got the total disregard for accuracy, reasonableness, and logic. But he doesn't manage to achieve the momentum that saved Smith from obscurity.

Of recent years, I have found my taste turning away from grand heroic fantasy of the sort in which Michael Moorcock seems to specialize. Still, I have enjoyed his work in the past, and when I found two new Moorcock novels on my doorstep, I thought I'd give them a shot. The first one I opened was **The City in the Autumn Stars**, a sequel to *The War Hound and the World's Pain*, which I reviewed in June 1982.

1. Instead of 2,144,000,000,000,000,000 cubic light years. The volume of a sphere is 4/3 × pi × r^3.

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If I recall adequately, *War Hound* ended when the finding of the Holy Grail ended the strife between God and Satan. Satan wound up with custody of Earth and the job of turning control of human fate over to humans. Unfortunately, though the Grail is the embodiment of harmony, that harmony continued to escape humans. Yet humans continued to try, until eventually they discovered or were led to the concept of the "Rights of Man"[2] and invented the American, French, Russian and numerous other Revolutions.

War Hound's hero was a von Bek. That of *City* is his descendant. Manfred, who has been involved with the American Revolution and now labors for the French. But harmony is elusive, and the French rebels are turning upon themselves. Manfred flees, eventually to encounter a Scots con man with a hot air balloon and several schemes to mulct the rich, all to be made much easier if only Manfred will lend his noble name to the cause. He also meets the Duchess of Crete, is smitten with lusty infatuation, and pursues her fruitlessly. Meanwhile, alchemists are gathering. The rich are throwing money at the Scotsman. And before Manfred knows quite what is going on, he is aloft with the Duchess and the Scotsman, on their way to a mysterious city in the Middle Marches (read that as Elfland, and you will not be far wrong). There he learns that his lady love is one with the alchemists, who with Manfred and the Holy Grail—as soon as he finds it for them, please!—will seize the moment of the Harmonic Convergence to redefine human reality for the next millennium or so.

Moorcock's memorable characters may not be quite flesh and blood, but neither are they cardboard; rather, they are actors, given to grand gestures and posturings. The stage he sets is striking. And his point . . . Well, I doubt that Satan or Harmonic Convergences had much to do with the birth of the modern age, but certainly the American and French Revolutions, the "Rights of Man" idea, did. From the search for harmony did such things arise, and if we have not yet quite managed to achieve our Grail, there are omens of success, and the search goes on.

The second Moorcock was **The Fortress of the Pearl**. And it's part of a series—the Elric saga—I thought Moorcock had wrapped up long ago. What he has done is step back in Elric's history to tell us of an adventure that took place in the saga's earlier days, when Elric visited the decadent desert city of Quarzhasaat, where water is more precious than jewels and a stranger's life is worthless in at least two senses. There he runs out of the herbs that sustain his life against his inborn weakness. He is dying.

But wait! An ambitious local nobleman gets wind of him, revives him with a draft of a slow poison and tells him that if he will visit the desert nomads and steal their chief treasure, the Pearl of the title, he will gain the antidote to the poison and wealth beyond imagining. The nobleman has no idea of Elric's true identity or nature, nor hence of the doom he has just invited.

Elric therefore sallies forth, finds the nomads, and learns that the Pearl and its Fortress reside in the mind of a local princess, who sleeps eternally, victim of a Quarzhasaat plot. He acquires a dreamthief ally and learns that it will take a dreamthief—one who steps into the mind of another to remove, in phys-

2. I always knew the "Rights of Man" were the work of the devil!

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ical form, dreams or obsessions; those stolen objects can then be sold for great sums in a certain marketplace. Together, they enter the girl's mind, survive assorted perils, retrieve the Pearl, and awaken the girl. Then, finally, he returns to Quarzhasaat to visit justice upon it and its denizens.

Justice. Here is what Elric and Moorcock say about that: ". . . there was no life worth living that was not risked in pursuit of knowledge and justice . . . One must give up power if one was to achieve true justice. This was not the logic of Empire, but it was the logic of one who truly loved the world and desired to see an age dawn when all people would be free to pursue their ambitions in dignity and self-respect."

And we're back to the Rights of Man, aren't we? Enlightenment, but not in the mode of the alchemists or the New Age cheesebrain mystics. Here is Moorcock's main concern, pounded at us, repeated in various idioms, presumbly in hope of penetrating the concrete shells surrounding the minds and souls of those who still believe the highest human activities are lies and deceit and the manipulation of others, and the highest human goals are power and wealth.

Yes, I enjoyed the books. May you also, and may you learn from them.

Some time back, I praised Rebecca M. Meluch's work. Now I have a chance to do it again, for she has a new book out, **War Birds**. (And still another, *Chicago Red*, is scheduled for June 1990, not long after you read this review). It is set around a distant star with three habitable worlds, each of which was colonized from Earth about two centuries before the time of the story. One, Tannia, was settled by self-indulgent democrats. Erd's people are descended from militaristic European aristocrats. Occo was chosen by a Third-World contingent eager to keep their distance from those whose ancestors had long exploited them back home. Fairly recently, Erd tried to conquer Tannia, but the latter's people speedily mobilized, developed a number of clever technical innovations, won the war, and suppressed Erd much as the US did Japan after World War II. Now ex-POW Anthony Northfield teaches literature at a Tannanian military academy. He had been a spaceplane (fighter) pilot and a notorious ace. Now he is tolerated as long as he keeps his head down, though he remains suspect.

Northfield falls in love with a student. Another student, a young jock pilot amused by Northfield's pretensions, takes the girl away. Eventually, the two men fight a spaceplane duel. Northfield wins and is promptly returned to prison. But now the Occans attack, and Tannia must mobilize its every resource, including its POWs and the Erdan underground. Northfield winds up in an Occan labor camp and discovers that the Occan colonists made the mistake of teaching their technology to a native sentient species that promptly enslaved them far worse than their ancestors had ever been enslaved on Earth. These natives have a biology that makes their society a caricature of human society in its dominance-submission games, but Northfield finds commonalities with the head of the labor camp, who happens to be another grounded spaceplane pilot.

The structure of modern popular fiction being what it is, there can be no doubt that the Tannians will find new technological gimmicks and defeat the Occans, nor that the hero (Northfield) will get the girl. But Meluch has a "passion for World War II fighter aircraft," according to the "About the au-

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thor'' note at the back of the book. She is presumably intimately familiar with the tales and memoirs that accompany those aircraft, and she has used that familiarity to explore the psyches of fighter pilots on the ground and in the air while translating the world of those pilots into distant space and time. That is, she has written a military SF story, but her emphasis is much less on justified slaughter than it is on the characters of those who commit the slaughter. Further, she convincingly supports the idea that slaughter is not really the pilots' aim. Rather, they live for the way their symbiotic relationship with their machines makes them something more than merely human, something clean and noble and supremely competent.

It works well. Meluch has once more done a marvelous job of creating fiction. I enjoyed her tale immensely.

Some of our fighter pilots have been fortunate enough to become astronauts. The ''Right Stuff'' is the same stuff for both, and Rebecca Meluch must surely have as much affinity for the latter group as for the first. So, I think, must all of us who share an interest in the technological side of SF as so often expressed in this magazine. And she and we must all weep when we think of recent history.

I'm putting this column together at the end of July 1989. That was the twentieth anniversary of the first Moon landing, when it now seems that the Space Age peaked. Tsiolkovsky and Goddard had brought the technology of rocketry to the embryonic state and dreamed of orbits and Moon landings and journeys to distant planets. Wernher von Braun and his colleagues had brought rocketry to sturdy infancy in the service of the Germans and at the end of World War II fled deliberately toward the Allies and America, which they were sure held the future, and space, in the palm of its hand. There they languished, victims of the typical shortsightedness of politics, until the Russians, with the lesser portion of the German rocket technology they had seized, put Sputnik into orbit.

I was only thirteen in 1957. I remember that galvanizing time, and the satellites that followed. In no small part, it was headlines that led me to science fiction, and the two together fed the yearning for space that, for me and many others, was the hallmark of the sixties. Not civil rights. Not Viet Nam. Not the Great Society. But *Mercury!* And *Gemini!* And *Apollo!*

As I type those exclamation points, my spine shivers. And then I think of what followed. *Apollo* died, put on the shelf because it had achieved its goal of beating the Russians and because any real progress beyond that point—space stations, Moon bases, Mars trips—was too expensive. The Space Shuttle was hamstrung by compromise. Boldness and daring withered in the face of danger. And the nation lost its vision and its commitment to a future that was anything greater than business as usual.

Meanwhile, the Russians were slowly and painfully—persevering through disasters far more numerous and severe than those to which the US surrendered in the name of risk-avoidance—building a lasting presence in space. They haven't been to the Moon or Mars, but they do have a space station. They have many times the US's man-hour experience in space. They are progressing, slowly but steadily.

I have seen the future, and it is red.

That thought was utterly inconceivable in 1969. It isn't, now. And it makes me want to cry.[3]

I suspect Buzz Aldrin feels the same way. I've just finished reading his and

3. As a biologist and an SF fan, I am delighted that *humanity* is going to space. That is what

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Malcolm McConnell's **Men from Earth**, a history of the early Space Age as seen by one of those who helped to make it. Aldrin, for those of you who have forgotten, was the second man to set foot on the Moon. Neil Armstrong went first. Once he was out of the way, Aldrin squeezed through the Lunar Module's narrow hatch, and then . . .

They were, all of them, those first astronauts, ex-fighter pilots and test pilots. They were heroes. The culmination of all human striving. And then the nation said, "Sorry. We don't need you anymore." The result—I'm reading a bit between the lines here—was crashing disappointment, alcoholism, recovery, and finally this book, in which Aldrin tells the story, from the immense advantage the US gained when it acquired von Braun, to the eventual failure of vision and will and commitment.

Will the US ever return to space as SF fans and Meluch, among others, have dreamed? Will we build habitats and colonize the Moon and explore the planets? Will we step forth into the galaxy? There are signs. Aldrin remains optimistic. But he also expresses considerable admiration for the Russians. They began without the von Braun advantage. Their space technology has been less sophisticated. But that technology has worked. And their vision and will and commitment have not faltered. ■

will matter to future centuries and millennia. But I am an American, too, and I hate the thought that some other nation, one in fact that we have long regarded as an ideological and technological inferior, will beat us at our own game. Not that what I hate or don't hate makes any difference to reality.

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brass tacks

Dear Dr. Schmidt,

As an economist, I found it interesting that new authors did well in the Analytical Laboratory of July 1989. The results, you report, are just for the best stories, not the average stories, but you have the data available to test a number of interesting hypotheses. Do new authors do better on average than old authors? Or the same? In either case, you as editor are perhaps not optimizing. Editing and publishing a new author has investment value, and hence you should be willing to accept a lower average short-run return. If new authors do worse on average, then the amount by which they do worse shows the valuation you put on this investment. With a little statistics and some linear regressions, one could also separate out the effect of an author having one, two, three, or *n* articles published.

Two considerations cloud the situation, however. First, maybe readers skip stories by new authors. You probably have data on this, too. Then you might wish to require new authors to write better stories than old authors because readers skip them. If you do follow this policy, however, then readers are irrational—because if they read them, they will like new stories better on average.

A second consideration is that new authors may have higher variance: more excellent stories and more rotten stories, even if the average is the same as for old authors. Is high variance good or bad? Hard question. I like it, but that is because I prefer to skip all but the excellent stories, and it takes fewer pages to tell if a story is rotten than to tell if it is mediocre.

ERIC RASMUSEN
ASSISTANT PROFESSOR
Los Angeles, CA

Your questions might make a good thesis subject for somebody, but I don't

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have the answers because I haven't compiled the statistics and am not likely to bother. My main interest is in producing the best possible magazine, and that depends more on judgments about individual *stories and authors than statistical patterns. For the record, though, I'm not aware of any systematic pattern of new authors doing either better or worse than old ones in the polls, or of readers systematically avoiding new authors. My hunch is that most readers, like editors, are always glad to find new talent, and recognize that new talent is likely to (a) need encouragement, and (b) show the effects of inexperience to some degree. Thus I will sometimes accept a story from a newcomer which I would send back if I got it from an old-timer who I knew could do it better. On the other hand, sometimes a brand-new writer comes up with a real blockbuster, and the readers seem as delighted as I am when that happens!*

Dear Dr. Schmidt,

In the July issue, a letter from Mark Shurtleff discussed "human factors" engineering briefly. I am reminded of two interesting cases: Just after WWII one aircraft company designed a jet aircraft that would park on its tail and take off and land vertically. On its first (and probably only) test flight, everything went fine until the landing approach. As the pilot descended he suddenly began to lose control; the plane began to go up and down in larger and larger oscillations. The pilot aborted the landing attempt by climbing out. After several similar attempts, a landing was accomplished with some damage to the plane.

In analyzing the problem, it was found that the "time constant" of the human response coupled with the time constant of the aircraft control system (primarily the inertia of the engine) comprised an unstable system; that is, it tended to oscillate. The engineers had forgotten to include the human time constant in their calculations.

Incidentally, the Volkswagen "Bug" with two soft rear tires had a similar problem, as I discovered personally. At speeds above about 25 mph. steering became impossible; the car/driver combinatiton would go into lateral oscillation that increased in amplitude and the driver was completely helpless until he got the speed down to a critical level.

It seems that the problem with the Audi 5000 was also a poor design from the "ergonomic" viewpoint. Studies seem to indicate that the sudden acceleration problem was not a mechanical defect. I think, however, that Audi made a serious mistake when they insisted that the problem was with the driver and not with the car. Obviously, just from the statistics, something was wrong with the car. Again it was a mistake to claim that the design was vindicated by these studies; the "human factors" aspects of the design were clearly faulty.

ARTHUR E. SHERBURNE

Hollis, NH

To the Editor:

You may or may not publish this letter, but in any case I hope you will pass on a copy to "Amaryllis," and perhaps to some of the brass in the Planetary Society; I, too, have become thoroughly fed up with their "surveys."

When I received the first one, I did exactly as Amaryllis suggested; I answered all the questions as honestly as possible, and wrote a letter explaining where I differed from them, and why, and what sort of space development I would like to see, and why. (I fear I admitted to the heresy of considering SETI an upscale cargo cult.) They sent

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me another copy of the survey. I wrote again and answered the questions again. (I fear I was sufficiently annoyed to remark that they had their nerve asking for my money, which I can ill afford to spare, when they clearly weren't interested in my opinions.) They sent me a third copy of the survey. On this I printed in large red letters, TAKE MY NAME OFF YOUR MAILING LIST, and sent it back, thinking this would be the end of it.

But no. Just a few weeks ago I got another copy of their survey; this one seems to be bit shorter than the others, but it amounts to the same thing.

Now, they may well be too busy to answer every Tom, Dick and Jane who sends them a letter, but this last would suggest they aren't even *looking* at the surveys. Shake it to see if a check drops out, then throw it away. At best, it means that the survey is quite pointless; they know what they want, and are only interested in hearing from those who agree.

Given this, it seems to me it would be far more honest to send out a brochure stating something like, "A, B, and C are the space programs we support, for the following reasons, and this is what we have been doing to further these programs. *If you agree*, will you give us your support?"

In any case, continuing to push for a Mars expedition, giving what we have learned about the reaction of the immune system to weightlessness, seems ridiculous. Better to concentrate on local development, a larger space station, a Moon base, experiments to see if continuous acceleration might counteract the effect, and so on. Perhaps it will take genetic engineering to let us live in space, who knows? But for the time being, local development would let us rotate people in space, maybe with volunteers staying for longer and longer periods, until we can figure out how to solve this problem. In the mean time, I will keep my subscription to *Analog*.

MARGARET HOWES
6523 Unity Ave. No.
Minneapolis, MN 55429

Dear Mr. Schmidt:

After reading Mr. Bova's guest editoral "The Either/Or Fallacy," (July 1989) I can see why he became famous for writing fiction. He wrote of a congressional budgeting process nonexistent in this world. In fact, he demonstrated another fallacy of reasoning: the Straw Man Argument.

Mr. Bova constructed a false and, therefore, easily defeated method by which the federal budget is arrived at.

Whether we space program supporters like it or not, our space program *is* a luxury. It rightly goes behind other more critical needs. The simple fact is our federal budget does not have sufficient income to meet even current demands. I strongly believe in space exploration, but I would first fund better education (smaller class sizes, higher teacher salaries, more college student grants), replacement and expansion of our transportation infrastructure (roads, mass transit, etc.), a true and realistic welfare system (no state currently provides benefits to meet even 60% of the poverty level), and much better medical care (AIDS research—the slow Black Death of the 20th century, and lowering our infant-mortality rate, the highest of any industrialized nation, to name two).

Mr. Bova commented the dilemma was "like asking if you want a roof over your head or food in your stomach." Millions of Americans face just such a choice. They are called the homeless.

The idea that Congress would budget NASA based on some ROI formula is

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truly creative fiction. If we space supporters wish to increase the budget for space, we should bite the bullet and vote/work for higher federal taxes. Instead of fighting *against* more deserving programs (and their more numerous constituencies), we should join *with* them to enlarge the money available.

Until such time as Americans are willing to pay the necessary taxes (and we pay a smaller percentage of income in taxes than all other industrial nations), the space program will remain an underfunded luxury.

STEVE STAPLETON

Sacramento, CA

The author replies . . .

Dear Stan:

There is one point, and one only, in Steve Stapleton's letter that I can agree with. He says that, "The idea Congress would budget NASA based on some ROI formula is truly creative fiction." I agree. It is fiction because of voters such as Steve Stapleton. (I presume he does vote.)

It is truly sad to see a reader of *Analog* accept so uncritically the mythology that the politicans and the media have been dishing out for so many years. Stapleton says that he believes the space program is a luxury, because "the simple fact is that our federal budget does not have sufficient income to meet even current demands." His idea of a cure? "Bite the bullet and vote/work for higher taxes."

That is like "curing" a glutton by giving him more food. The simple fact is that the more money governments receive from taxes, the more money they spend—and they spend it where the biggest lobbies are: agriculture (including tobacco), well-entrenched industries such as oil and automobiles, social welfare.

I do not intend to argue the pros and cons of all those government programs. Some of them are manifestly sinkholes of money that show no sign of solving the problems they were created to solve. What Stapleton does not realize is that space can help our economy to grow, and thereby help to provide the money needed for various government programs.

Instead of trying to extract a constantly larger slice of tax money from the national economy, why not help the economy to grow by investing wisely in one of the few areas that has produced valid, documented, and well-nigh astounding growth? The technologies that have been developed for space are already producing hundreds of billions of dollars for the GNP each year. Space is an investment in our economic well-being, not a luxury.

BEN BOVA

Dear Dr. Schmidt;

Re: Mr. Bova's guest editorial in July's issue: OK, I think I've heard just about every big name in the Science/Science Fiction world expound on the problems faced by dreamers of space development on a large scale in trying to get money out of Congress. The problems as I've heard them stated are, simply, lack of interest, ignorance, and division of those who seek the extra money for space. Mr. Bova merely defined more closely the divisiveness we already know about.

The big question that faces us is not what *is* the problem, but how do we solve the problem? More editorials and articles that point out various faces of the same problem may be helpful, but are not enough. How do we educate the masses to see that the solutions to many of their problems may solve themselves with the development of space? It seems that Congress will try to get away with

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anything people let them get away with. If everyone, not only those of us who read science and sf journals, knew what we think we know, it wouldn't be so easy for men like Proxmire, et al, to ignore, or even deride space development. NASA wouldn't have to compromise on the either/or method to get anything done. Private companies could be partially subsidized or otherwise helped out with public monies.

How do we educate people on the benefits without having them think that we are a bunch of dreamers who have our heads in the clouds? That's a good question, one that I don't have the answer to. Nor, evidently, does anyone else. Why don't we have more articles on the "how" rather than the "what"? Even if they're only guesses that people may laugh at. Maybe it'll get more people thinking along those lines.

I can think of one method that already exists; so-called "space societies." But every time I think of joining a "society" or a club that expounds the idea of space travel, I hesitate and rethink what I am considering. There are so many of these organizations that send me mailings. All of them want money to further their ideas, which seem to fall in line closely with others (not including the ones that have too narrow a goal, such as a trip to Mars or development of the Moon, etc). With so many organizations and so few people who are interested, how could any one possibly amass enough money and influence to do anything. It's throwing good money after bad, to use an old cliché.

If these societies could put aside their pride and differences, develop one program and attack it together, maybe something could be done, as has been suggested before. But how? And who will do it? It needs to be someone with some oomph in the science world. Someone all these fragments would follow.

Even that wouldn't be enough, though. What about the people? Congress would still be able to reroute this new organization because it wouldn't have the full backing of a large percentage of the people. Look at all the people who own guns. Put that with patriotism and "the right to bear arms," and too many people are affronted by the suggestion that we control guns. We lose too many "freedoms." All it takes is solidarity and a common interest.

I know very few people who read science fiction or are interested in science. I work for an engineering company, and only two or three of the "well educated" people who work there really give a damn about whether or not we succeed in space. They, as most Americans, are worried about "solving problems here on Earth first." Hell, these are the educated ones! What about the average secretary, or highway builder? They just want their problems solved. They're tired of living in tiny apartments or run-down houses in neighborhoods where crack dealers and gangs flourish. How does space development directly affect them? Until we can convince these people of the future, of what space development can bring about, rather than the semi-feudal way they believe it will always be, we'll always come in second to the Soviets and the Japanese in the space race.

LARRY CHESEBRO

Houston, TX

The author replies . . .

Dear Stan:

The problem with idealists is that they tend to stay out of the fight. It's easy to ask, "How do you intend to solve these problems?" It is much tougher to get out into the battlefield and actually *work* toward solutions.

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If Mr. Chesebro is seriously interested in helping us to become a space-faring people he should join the National Space Society. Contrary to his claim, NSS is one of the only two large international space activist organizations. The other is Carl Sagan's Planetary Society. NSS has brought together under its aegis the former National Space Institute, the L-5 Society, and many smaller pro-space groups. NSS also works closely with SpaceCause and SpacePac, which are lobbying organizations, as well as other space-oriented groups in industry, academia and government.

NSS helped to make space an issue in the 1988 presidential campaign. NSS encouraged President Bush to aim for a return to the Moon and a mission to Mars in his policy statement of July 20, 1989. NSS is helping to educate the American public with TV programs, a monthly magazine, telephone hotlines, and many other activities.

To all those idealists who want to see us move into space in a major way, I beg you to get up off the bench and into the game. You'll get bruised, certainly. But you'll be *helping!*

BEN BOVA

Dear Stan,

In Rick Cook's well-wrought article, "Neural Nets" (August 1989), he says (p. 97): "There are theoretical reasons to believe that an intelligent neural net would be so complex we could never understand it." That's remarkably like Emerson Pugh's, "If the brain were simple enough for us to understand it, we would be too simple to understand it." I'm quoting from memory; Pugh probably said it better. Add that to Cook's "spooky similarities" (p. 92).

As he says, psychologists seem divided on how the human mind works—or at least on how we should go about trying to understand it. Operant conditioning types (behaviorists) are disdained by cognitivists, for example, because they can't or won't explain every aspect of thinking. Behaviorists scorn cognitivists for their "fuzzy" concepts and acceptance of non-quantitative data.

Meanwhile, the brain's tens of millions of neurons are quite capable of generating a mind that works both ways, simultaneously or alternately. If you want to teach arithmetic, typing, or even engine troubleshooting, operant conditioning seems to fit the mind's requirements superbly. However, so far, at least, operant conditioning techniques go only part way in teaching medical or psychopathological diagnosis. But, hey!, they do that part in a lucidly systematic manner.

It seems likely that the behaviorists and cognitivists are both right—that the mind prefers to work on discrete, well-defined things in one way and on ambiguous, open-ended problems in another. Most genuine problems contain both elements, so maybe significant advances in neural nets will only be made in conjunction with artificial intelligence.

Cook may be right when he says (p. 95) that humans recognize "U-ness" in even the partial pattern that best matches "the one they are searching for." But that's not the only way we do it! If we know it's a letter, and it isn't any of the others, we can figure it must be a U. If I understand Cook, from whom I just learned everything I know about neural nets, that's possible though perhaps cumbersome for a neural net, but it's a snap for a mind. Nearly 50 years ago, I worked in a tax office and had to decipher nearly illegible signatures on checks. One major tactic was to narrow

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the guessing range by eliminating what a letter probably wasn't. Master troubleshooters work that way, too.

Many concepts are defined in the mind partly, largely, or even solely by non-examples of the concept. In a cross-cultural conflict of the Us-Them type, an extraordinarily heterogeneous "Us" may be sharply defined solely by exclusion of "Them." The same defining principle (solely by exclusion of non-examples) can be a highly productive approach to ill-defined problems. Is this why, as Cook says (p. 90), "neurons which inhibit signals are at least as important as ones that pass signals . . ."? Maybe they are much *more* important in a neural net that is trying to do things a computer can't.

Consider: it is possible for you to win at the game of Twenty Questions when every question you ask gets a negative answer! And the target could be any of a billion things from a wooden nickel to Lincoln's beard! (Pure math won't give you the odds because humans are shrewd guessers.)

Also consider: if you were designing an amoeba, it might be more efficient for it to recognize only what isn't ingestible and eat anything else. Learning what to ignore and thereby unburdening your mind of it is an enormously important survival mechanism. If I ask if you have shoes on, you needn't look; your brain has been getting a message from your feet all along but you'd been purposefully ignoring it. Deciding what's irrelevant can be more significant than deciding what's relevant. In fact, one insidious disease of problem solving is deciding too early what's relevant. Sometimes it helps to shift your thinking to what's not irrelevant!

Well then, how do we know what a chair "is"? (By the way, Korzybski would probably *not* have used the word "is" even as a ghost.) We recognize chairs partly by knowing some examples, and partly by knowing millions of non-examples such as desks, lawn, lasagna, etc. (By the way, Korzybski's galloping ghost (p. 89) probably *would* have used "etc." in his definition of a chair.)

It might be interesting to hypothesize a huge neural net that could play Twenty Questions. That seems theoretically feasible. Could one also be made that simulated "etc."?

Obviously, Stan, you've given us another highly stimulating article! My thanks to Rick Cook and you.

FRANCIS CARTIER, PH.D.

Stan:

I enjoyed Tom Easton's review of *Prentice Alvin* by Orson Scott Card, but was utterly appalled at his selection of the white/black breeding described therein as somehow having a basis in LDS ("Mormon") doctrine. His cited justification is based on a rather distorted reading of a few passages out of the *Book of Mormon* which describe the natural consequences of one group's cultural choices (nomadic, hunter, gatherer) over those of another's (settled, farmer, merchant). From the viewpoint of the "civilized" group, the "dark" skin of the nomads (these were all Semites, so the differences were relative) was seen as a curse, reflective of the lifestyle chosen; when the nomadic groups settled into a more civilized lifestyle, the "curse" was lifted. Ironically—in the light of Easton's comments—the *Book of Mormon* describes the most valiant and spiritual groups as coming from the nomadic ("dark") culture, while the worst atrocities and greatest crimes were committed by the civilized ("light") culture, which was ultimately destroyed.

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In fact, rather than justifying discrimination, the *Book of Mormon* condemns it in many places, most notably in the form of a scathing sermon by a leader named Jacob to a group of sanctimonious, self-righteous Nephites (the civilized "light" culture) concerning their bigotry towards the nomadic group (Lamanites). Here's a brief excerpt: "Behold, the Lamanites your brethren, whom ye hate because of their filthiness [those dirty nomads!] and the cursing which hath come upon their skins, are more righteous than you . . . Wherefore, a commandment I give unto you, which is the word of God, that ye revile no more against them because of the darkness of their skins; neither shall ye revile against them because of their filthiness; but ye shall remember *your own filthiness*, and remember that their filthiness came because of their fathers [i.e., it's their culture and tradition; what's your excuse?]." (Jacob 3:5,9; emphasis and editorial comments mine)

While Easton's gaffe was regrettable and avoidable, his original point was correct: Card's *Tales of Alvin Maker* contain many reflections of and parallels in LDS doctrine, theology, and history. In doing so, Card is creating a modern version of one of the most ancient forms of literature, one in which a major spiritual figure, either directly identified or somewhat disguised, is shown going through a series of ritual adventures and confrontations from infancy through adulthood. In Judeo-Christian literature, these writings are known collectively as *apocrypha* ("secret writings") and *pseudepigrapha* ("falsely written", i.e., unauthorized or fanciful biographies) and often involve figures such as Adam, Enoch, Methuselah, Noah, Abraham, Melchizedek, Christ, and the early Christian apostles. Card's contribution to the genre is masterful and significant; my only complaint is that he doesn't write 'em fast enough.

BRUCE F. WEBSTER

Soquel, CA

Dear Stan

I've sent a letter thanking Tom Easton for his kind review of *Men Like Rats* in the September ish of *Analog*. I must correct one misconception, however: I've written nothing else on this subject. I think he was thinking of Tom Disch's *The Genocides*, which I have just bought but have not yet read. (It looks good.) I understand, however, that it ends with the total extermination of the human race.

At that time (1965), the racks and magazines were overrun with books and stories depicting mankind throwing off the leash of alien conquerors, a genre of L. Ron Hubbard was revitalized (as bad as the stuff we used to see). Disch, fed up with this drek, did the Campbellian thing: took a fresh, logical (and humorous) look at the question. The result was denounced as anti-Campbellian, though not, I believe, by Campbell.

ROB CHILSON ■

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a calendar of analog upcoming events

2-4 March
WOLFCON 1990 (Nova Scotia SF conference) at Beveridge Arts Centre, Acadia University, Wolfville, N.S. Registration—C$10 until 1 March, C$15 at the door. Info: Wolfcon, Box 796, Wolfville NS Canada BOP 1X0. (902) 542-9306.

9-11 March
WISCON (Wisconsin SF conference) at Holiday Inn Southeast, Madison, Wisc. Guests of Honor—Emma Bull, Iain Banks. Info: SF³, Box 1624, Madison WI 53701-1624.

23-25 March
DemiCon I (Iowa SF conference) at Howard Johnson, Des Moines, Iowa. Guest of Honor—C.J. Cherryh, Artist Guest of Honor—Robert Daniels, TM—Rusty Hevelin. Registration—$15 until 15 February, $20 thereafter. Info: DemiCon I, Box 7572, Dept. W., Des Moines IA 50322-7572.

30 March-1 April
READERCON 3 (literary-oriented SF conference) at Lowell Hilton, Lowell, Mass. Guest of Honor—John Crowley, Special Guest—Thomas M. Disch. Registration—$20 until 20 February. Info: Readercon 3, Box 6138, Boston MA 02209. (617)576-0415.

30 March-1 April
TECHNICON 7 (Virginia SF conference) at Donaldson Brown Center, Blacksburg, Va. Mostly gaming, artshow, costuming. Info: Technicon 7, % VTSFFC, Box 256, Blacksburg VA 24063. (703)953-1214.

13-16 April
EASTCON '90 (British National SF Convention) at Adelphi Hotel, Liverpool, England. Writer Guest of Honour—Iain Banks, TV Writer Guests of Honour—Nigel Kneale and Ken Campbell, Art Guest of Honour—SMS. Fan Guest of Honour—Anne Page. Theme—Putting the Science Back into Science Fiction. Registration £20 until 1 December 1989. Info: 15 Maldon Close, Camberwell, London SE5 8DD. US Agent: Mary Burns, 23 Kensington Court, Hempstead NY 11550.

23-27 August
CONFICTION (48th World Science Fiction Convention) at Netherlands Congress Centre, The Hague, Netherlands. Guests of Honor—Joe Haldeman, Wolfgang Jeschke, Harry Harrison; Fan Guest of Honor—Andy Porter. Registration—$65 until 31 December 1989. Supporting—$28 until 31 December 1989. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Join now and get to nominate and vote for the Hugo Awards and the John W. Campbell Award for Best New Writer. Info: Worldcon 1990, Box 95370, 2509 CJ The Hague, Netherlands. Enclose sufficient International Reply Coupons for airmail response.

30 August-3 September
CONDIEGO/NASFiC (North American SF Convention) at the San Diego Omni Hotel International, San Diego, Calif. Guest of Honor—Samuel R. Delany, Fan Guest of Honor—Ben Yalow. Registration—$65 until 1 January 1990, $75 thereafter, $85 at the door. Supporting membership—$25. Info: ConDiego, Box 15771, San Diego CA 92115.

—Anthony Lewis

Items for the Calendar should be sent to the Editorial Offices six months in advance of the event.

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Garden City, NY 11530

YES! Please enroll me in *The Science Fiction Book Club* according to the risk-free membership plan described in this ad. Send me the 5 BOOKS I've indicated. Bill me just $1, plus shipping and handling.

Please write book numbers here:

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Members accepted in U.S.A. and Canada only. Canadian members serviced from Canada, where offer is slightly different. Sales tax added where applicable. We reserve the right to reject any application.

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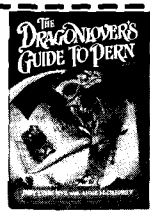

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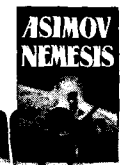

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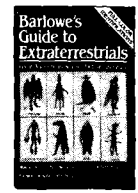

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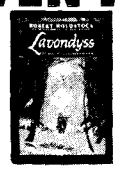

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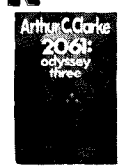

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THE Science Fiction BOOK CLUB®

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